SCIENCE

24 July 1959

Volume 130, Number 336

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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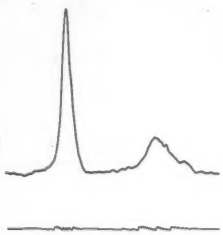

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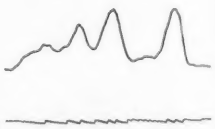

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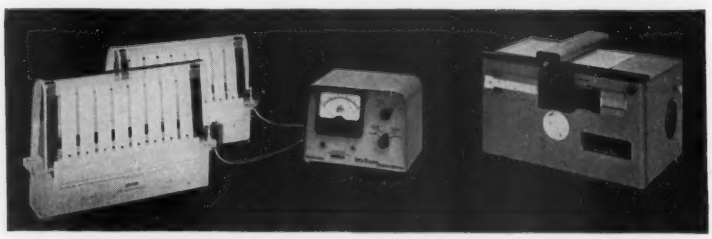

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Letters

Philanthropy

The letter of P. W. Hutson [*Science* **129**, 1369 (1959)], condemning the editorial which suggested increased philanthropy and argued its advantages from the federal income tax viewpoint, is amazing indeed.

Granted that private philanthropy may be irresponsible and wasteful, so may our tax-supported philanthropy. But while the private philanthropist possesses direct control over the uses of his gifts, the taxpayer can stop paying otherwise compulsory taxes only by becoming a private philanthropist. Thus, the use of permissible deductions, plus expressions of opinion to his elected representatives, constitute the only indirect controls available to the taxpayer over the ultimate uses to which his tax monies will be put.

I disapprove of vast federal expenditures to enable us to send Mr. Smith to the moon and blow his family to smithereens while he is gone, and I take advantage of every legal provision available to reduce my federal income taxes. This is possible because of the deductions and exemptions permitted, and I intend to continue to give till it hurts.

It doesn't hurt, really, and it probably does much more good for all of us than sending anyone to the moon ever will. I urge my fellow scientists and citizens to do much more of the same.

C. H. LUSHBOUGH
American Meat Institute Foundation, University of Chicago

Science Teaching

Since the advent of the first Russian sputnik, Americans have indulged themselves in some very tardy, and much-needed, criticism of their educational system. Much has been found wanting, many ideas have been discussed, but very little has been done to alleviate the crucial deficiencies thus brought to light.

To judge from personal experience at three different collegiate establishments, the greatest impediment to the improvement of college courses in biology and botany seems to be a dogmatic and narrow-minded view of heads and chairmen of departments as to what such courses should include and how they should be taught.

What I am saying is that the "academic dry-rot," so well described by William Morton Wheeler several decades ago, in the meantime has decayed the structure of our educational system so thoroughly that the system collapses almost of its own weight under the continued onslaught of the specialists whose minds are sharp as razor blades and just about as broad.

Elementary courses are still taught as if the majority of students were to be science majors rather than citizens of a democracy. In contradiction to the essence of science, there is an abhorrence to experimentation, presumably on the assumption that Louis Agassiz and Asa Gray knew all there is to know of college teaching.

Within this adolescent frame of reference, course improvement means "cramming" the lecture with more subject matter and the laboratory with more experiments that repeat the material of the lecture, at the same time restricting the entire scope of the course to plodding through the textbook.

According to this pedagogical outlook, lecturing in an elementary course is delegated to the newest and least capable member of the faculty, and the laboratory sections are handed over to well-meaning graduate students whose only qualification for teaching is that they are promising candidates for the Ph.D.

Apparently, the practical implications of general education, as well as the dire need for all citizens of a democracy to have a general knowledge of science at this time, are still not recognized by the great majority of biologists in general, and by those in charge of instruction of elementary courses in particular. And in fact, among the orthodox, the instructors of courses in general education are automatically relegated to an inferior status in the academic hierarchy.

I do not doubt that there are intelligent heads or chairmen of departments of biology and botany to be found, but in 9 years of searching I have encountered only one who had the guts to advocate an elementary course which was frankly experimental and openly oriented to general education. Nowhere, it seems, is the spirit of science so dead as in elementary biology and botany courses.

LEO F. KOCH
Division of General Studies, University of Illinois, Urbana

The growing pressure from our government to improve and extend science teaching in the high schools has raised serious questions concerning the best ways to attract and hold the interest of high-school students with respect to science.

The common method has been either to specialize—that is, give courses in physics, chemistry, and so on—or to give science survey courses that offer a little bit of each science. Would it be feasible to teach high-school science in terms of a *connected theme* of common interest that would serve to link in a meaningful way the various areas of the sciences (and mathematics)?

PHOTO BY WILL CONNELL

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During the summer of 1959, at the University of Oklahoma, I will be engaged in a National Science Foundation program for high-school science teachers. The National Science Foundation course (which is one of several to be offered at the university at that time) is on cosmogony and evolution. It deals with the scientific theories of the origin and development of an expanding physical universe; the appearance of the basic "particles" (hyperons, protons, electrons, and so on); the emergence of atoms, molecules, and extragalactic nebulae; the stars and the planetary systems; the formation of the earth; and the emergence and evolution of life. In the course of this project we shall discuss scientific method and shall present the astronomical, physical, chemical, geological, biochemical, and biological details in such a way as to tie them in meaningfully with the history of the universe and of our earth.

We feel that among young people are many who may be readily motivated by the questions: "How did it all begin?" "How did the stars come to be?" "Where did the earth come from?" "Where and how did life arise?" With such a central theme, it becomes reasonable to hope that the technical and often boring details of mathematics and the specialized natural sciences will become more significant and interesting to the high-school student; the parts of knowledge will be acquired within a meaningful whole that should be more ego-involving for the student.

We have selected about 35 high-school science teachers, both men and women, from all parts of the nation (the majority are from Oklahoma) and ranging in age from the mid-20's to the early 50's.

We shall utilize the help of an astronomer, a biochemist, and a geneticist. The institute will be given jointly by David Kitts, a geologist-paleontologist, and by me (a philosopher of science and physicist). We have had consultation with Sidney Fox of Florida State University on the chemical origins of life, and we plan to demonstrate (ultimately for high-school science-teaching purposes) the emergence of amino acids and so on under conditions simulating the supposed natural conditions on earth prior to the origin of simple life forms.

We shall utilize all available audio-visual aids, including Atomic Energy Commission materials on atomic and nuclear theories, and astronomical observatory facilities, laboratory demonstrations, and scientific charts and literature on relevant subjects. Our high-school teachers will help us work out the best ways of implementing our program in the high schools. Obviously, we are going to need a great deal of help from the high-school administrators, and perhaps from government agencies, if this program is eventually to be deemed valuable enough to be introduced into the high-school teaching system.

CARLTON W. BERENDA
Department of Philosophy,
University of Oklahoma, Norman

Flycatchers and Warblers

In the legend to Fig. 4 of D. J. Struik's interesting historical article [*Science* **129**, 1103 (1959)], illustrations 2, 3, and 4 on the plate reproduced from Alexander Wilson's *American Ornithology* are described as "flycatchers." It is true that Wilson listed these birds in the genus *Muscicapa,* but this name is now confined to the flycatchers of the Old World. The birds portrayed on Wilson's plate 26 are members of the New World family Parulidae, the wood warblers. Their resemblance to the true flycatchers is superficial and has resulted from convergent adaptations to the flycatching habit.

It may be of interest to note that the three warblers shown on this plate are members of a genus named *Wilsonia,* in honor of the artist, by the great 19th-century ornithologist Prince Charles Lucien Bonaparte, nephew of Napoleon I. Illustration 4 on the plate is *Wilsonia pusilla* (Wilson), commonly called Wilson's warbler.

KENNETH C. PARKES
Carnegie Museum,
Pittsburgh, Pennsylvania

I am grateful to Parkes for his correction, which will be helpful to all who have wondered what kind of "flycatchers" were represented in Fig. 4 of my article.

It may also interest shell collectors to know that the *Fusus corneus* of Fig. 2 is now called *Colus stimpsoni* (Mörch) and the *Fusus cinereus, Urosalpinx cinerea* (Say), for which information I have to thank W. J. Clench of Harvard University.

I also received a letter from Thomson King, director of the Enoch Pratt Free Library of Baltimore, Maryland, who objected to my expression "Robert Fulton's inventions" for the successes of the steamboat; he stressed the merits of James Rumney and James Fitch and concluded with "It is rather ironical that Fulton actually invented and gave a demonstration for the English Admiralty of a submarine, hand driven. Now thousands of people believe he invented the steamboat and apparently no one knows that he really did invent the submarine."

D. J. STRUIK
Massachusetts Institute of Technology,
Cambridge, Massachusetts

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Radio offered the economical answer: a new microwave radio-relay system recently created at Bell Telephone Laboratories. Operating at 11,000 megacycles, it was just right for the distance, and the number of conversations that had to be carried.

But first other problems had to be solved: how to house the complex electronic equipment; how to assemble and test it at hard-to-reach relay stations way up in the mountains; and how to do it economically.

On-the-spot telephone company engineers had some ideas. They worked them out with engineers at the American Telephone and Telegraph Company and at Bell Telephone Laboratories. The result: a packaged unit.

The electronic equipment was assembled in trailer-like containers at convenient locations and thoroughly checked out. The complete units were then trucked up the mountains and lifted into position.

The system, now operating, keeps a watch on itself. When equipment falters, a relay station switches in standby equipment, then calls for help over its own beam.

The new Phoenix-Flagstaff link illustrates again how Bell System engineers work together to improve telephone service. Back of their efforts is the constant development of new communications systems at Bell Telephone Laboratories.

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SCIENCE

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Among the Missing

Biographical directories, like telephone directories and encyclopedias, rapidly become obsolete. Consequently, all who want biographical information about scientists—scientists themselves, administrators in government, industry, universities, and research institutions, editors of scientific journals, and science writers for the press, among others—will welcome the publication this fall of the first volume of the tenth edition of *American Men of Science*, the largest biographical directory in the world.

Inasmuch as the criteria for inclusion (achievement equivalent to the attainment of a doctorate, research activity of high quality, or the holding of a responsible position requiring scientific training and experience equivalent to the foregoing) have not been changed since preparation of the first edition, in 1906, the size of successive editions roughly reflects the increasing number of scientists in our population. As one looks at the volumes assembled on the library shelf, he is struck by the increase in bulk and notices that the eighth edition approaches the limit in size for a single book; that this physical limitation was recognized by the editor and his advisers is apparent, for the ninth edition appeared in three volumes (the forthcoming tenth edition will require five). The impression thus gained visually is borne out by the numbers of biographies included, which, in round numbers, are as follows (years of publication in parentheses): 4000 (1906); 5500 (1910); 9500 (1921); 13,500 (1927); 22,000 (1933); 28,000 (1938); 34,000 (1944); 50,000 (1949); 95,000 (1956); and 120,000 (estimated for 1959–62). As can be seen from the figures, the number of scientists listed increased about 30-fold, a much more rapid increase than for the U.S. population as a whole, which underwent a twofold increase during the same time.

But no biographical directory is ever all-inclusive. Despite the cooperation of virtually all scientific societies and all universities granting higher degrees, there are some people who cannot be located or who have neglected to supply biographical data. The first of the four volumes devoted to the physical and biological sciences, which will carry the biographies of scientists whose last names have initial letters from *A* to *E*, will soon be ready to go to press. Some 1800 people whose names should be included are known to be among the missing. Space does not permit us to list them all; they range from Torfine Leonard Aamodt (entomology, University of Minnesota, St. Paul) to Eugene Henderson Eyster (physical chemistry, Los Alamos Scientific Laboratory, Los Alamos, N.M.).

Any eligible person whose last name begins with *A, B, C, D,* or *E* and who is uncertain about whether he has sent the editor a biographical sketch, should write promptly to Jacques Cattell, Editor, *American Men of Science,* Arizona State University, 820 College Ave., Tempe, Ariz. Those who do so will be entitled to feel, as J. McKeen Cattell, editor of the first edition, expressed it in his preface to that edition, "in the fortunate position of knowing that whatever we do to promote our own interests is at the same time a service to the community and the world."—G.DuS.

24 July 1959, Volume 130, Number 3369 SCIENCE

Research in Space

Scientific opportunities, instrumentation problems, and sources of support are reviewed by the Space Science Board of the National Academy of Sciences.

A beginning has already been made in the exploration of the fringes of the atmosphere and of the regions of space outside the earth. The events of the past two years encourage the expectation that this exploration will proceed with increasing momentum.

The means now at hand, or soon to be available, for transporting instruments into space add immeasurably to the power and versatility of the tools of scientific investigation. Atmospheric attenuation limits the earthbound observer to the use of about 20 of the 60 octaves in the electromagnetic spectrum above 100 kilocycles per second: an additional 40 octaves are in principle accessible to instruments flown outside the earth's atmosphere. These opportunities are of the liveliest interest to physicists and astronomers. With the aid of artificial satellites and space probes, fields, radiation, and particles in interplanetary space and in the vicinity of the earth, the moon, and the nearer planets become accessible to direct observation for the first time. As space technology advances it will undoubtedly become possible not only to sample the matter in space but also to observe and perhaps to obtain samples of the material of the moon and planets: these prospects are manifestly of interest not only to the physical but also to the biological sciences.

In the conviction that the challenge posed by these unprecedented opportunities for scientific study deserves most serious attention, the National Academy of Sciences, through its Space Science Board, seeks to offer encouragement to those who wish to take part in space research programs. This article is addressed primarily to those scientists who may not yet have given serious consideration to the possibility of experimentation in space. It attempts to suggest the opportunities which are available and to outline some of the information which will be needed by those who wish to go further.

Opportunities

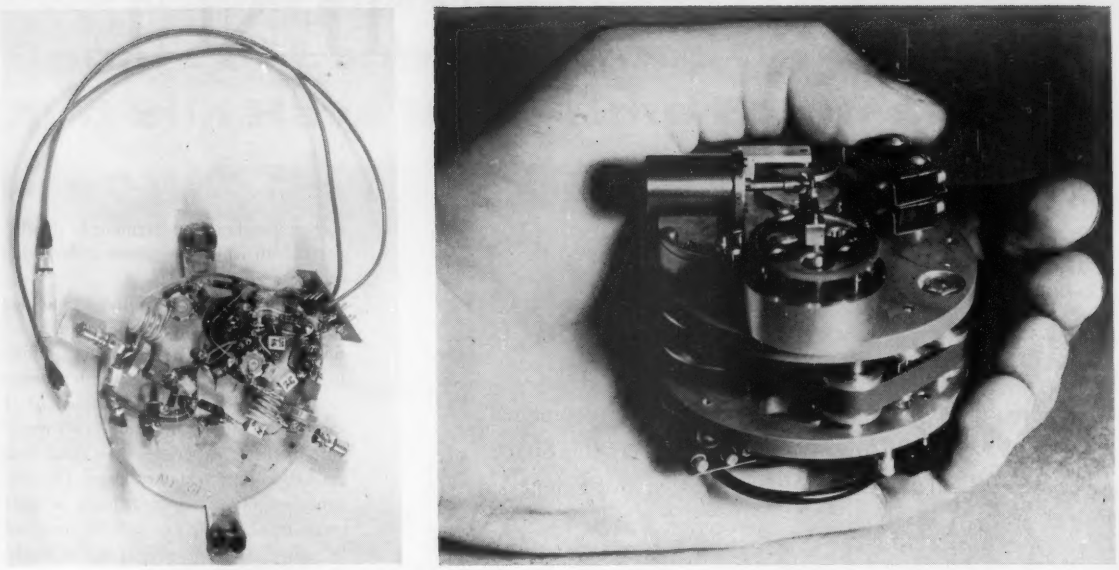
The establishment of the National Aeronautics and Space Administration provided the means for the continued development of a civilian program of space exploration. A major part of the tasks ahead is concerned with the development of more powerful, reliable, and versatile rockets, control systems, tracking and observing equipment, and instrumentation generally. Rapid technological progress in all of these is to be expected, and the attendant possibility that the supply of suitable experiments ready for flight will be outstripped is quite real.

Moreover, continued progress on the engineering side may be expected to lead to significant improvements in reliability, to permit simplification in the design of experimental apparatus, and to widen the variety of experiments which may be attempted. It is likely that there will be not only a rapid increase in the number of opportunities for conducting scientific experiments in space but also a corresponding improvement in the dispatch with which any given undertaking can be accomplished.

By the adaptation of the technology of rockets and space vehicles to scientific ends, it is at last becoming possible to study the universe free of interference from the absorptions and distortions of the earth's atmosphere and to investigate by direct experiment the conditions existing in interplanetary space. The new experimental techniques have already given results which cannot be matched by any other investigative methods. These circumstances, now in the process of evolution, challenge the ingenuity and enterprise of the scientific community as a whole.

Support for work in space research is provided by the National Aeronautics and Space Administration (1512 H St., NW, Washington 25, D.C.) and the National Science Foundation (1951 Constitution Ave., NW, Washington 25, D.C.). The Advanced Research Projects Agency (Department of Defense, Washington 25, D.C.) also supports work which pertains to its defense mission. Where special departmental interests exist, funds may also be available directly from other sources—for example, the research offices and establishments of the military services.

An individual scientist or a research institution seeking support for a project or program of research involving the use of rockets, artificial satellites, or space probes should make application to one or other of the agencies mentioned above. Besides discussing the scientific significance of the work proposed, it is desirable also to describe the experimental requirements for telemetry and any special problems involved in the reduction and analysis of data. The budgetary needs for the various principal stages of the project should also be presented. Applications to the National Science Foundation should follow the form prescribed in the leaflet "Grants for Scientific Research" which is available from that agency on request. When the other agencies are concerned it is preferable that the investigator apply informally in the first instance, giving at



Weight restrictions and environmental conditions have favored the application of miniaturization techniques to the design of apparatus for space vehicles. The minitrack transmitter (left) for a Vanguard satellite [Courtesy U.S. Navy]. A miniature magnetic tape recorder of the type which has been used in satellites for the storage of data (right). The stored information can be read out at will by command signal from the ground. [Courtesy U.S. Army]

least the information outlined above. (A leaflet "The Advanced Research Projects Agency," now available from the Department of Defense, Washington, D.C., summarizes information useful to those who may wish to make proposals to that agency.) Thereafter, discussion with appropriate members of these agencies will enable the proposal to be made in a form best suited to the particular case.

While some experiments require the use of satellites or space probes, high-altitude rockets will continue to find special application for many types of investigations. They are particularly useful for establishing the altitude dependence of phenomena of interest in regions below satellite altitudes. The National Aeronautics and Space Administration and the Department of Defense are actively interested in the support of research programs using rockets.

The nature and magnitude of the engineering effort which must accompany space science efforts make it necessary to pay much more attention than usual to the design and reliability of the experimental apparatus. As a general rule, space research projects proceed through a series of stages which may be enumerated as follows: (i) feasibility study leading to the design of experiments, (ii) development of experiments and instrumentation, (iii) development of flight packages, and (iv) launching operations, data reduction, and analysis.

The scale and complexity of the effort required in the third and fourth phases tend to be characteristic of the practical side of space research. This may give rise to some apprehension on the part of the scientist that his interests may become subordinated to those of engineering. While recognizing the importance of engineering to success in space experiments, the Space Science Board holds the view that throughout the course of the experiment the originator must participate actively to the maximum extent practicable. This view is shared by the responsible government agencies. The scientist engaged in a space research project may, therefore, expect to have close liaison with those responsible for the engineering design, construction, and environmental testing of the flight package and to have a voice in decisions affecting telemetry, the choice of orbit or trajectory, and the time of launch, insofar as these may affect the scientific aspects of the experiment. He may expect to participate actively in the instrumental testing of his apparatus before launching, and, of course, to have complete and immediate access to the results of the experiment.

As a practical matter, financial support is not limited to proposals which encompass all the stages mentioned above. In many cases, today's technology may be inadequate for an immediate realization of the experimental goals. Nevertheless, theoretical or preparatory investigations, in anticipation of future capabilities, may well elicit support. Here both the National Aeronautics and Space Administration and the National Science Foundation have genuine interests in sponsoring research.

The launching of an experiment in a satellite or space probe involves a significant expenditure of time, effort, and engineering resources, Preparation of a suitable scientific flight package accordingly requires careful collaboration between the authors of experiments and the engineers and scientists conversant with flight package design. The nature of rocket propulsion and the usual reliance on radiotelemetry for the recovery of results impose some definite characteristics on the design of experiments. The discussion which follows is intended to be suggestive of the present state of the art and should not be taken as definitive.

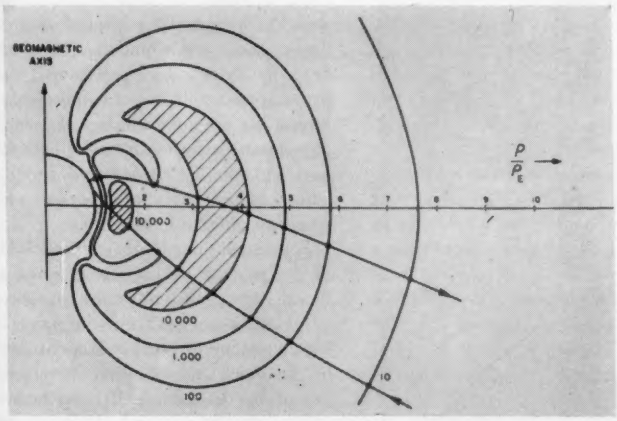
Vehicular Reliability

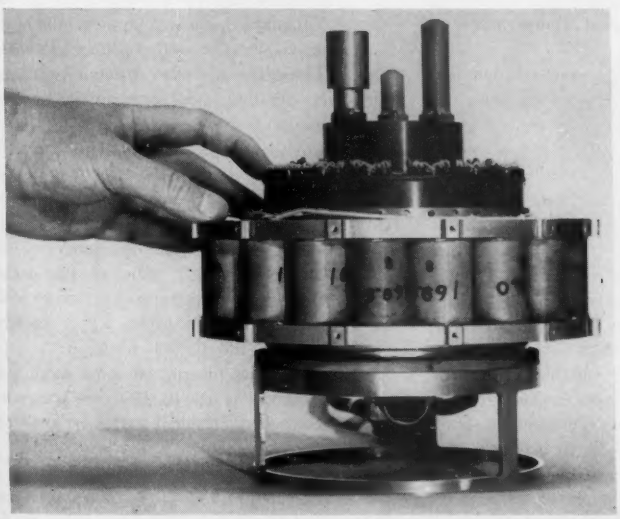
The problem of reliability has had a notable effect on early attempts to conduct research in space with high-performance rockets, both as satellite-

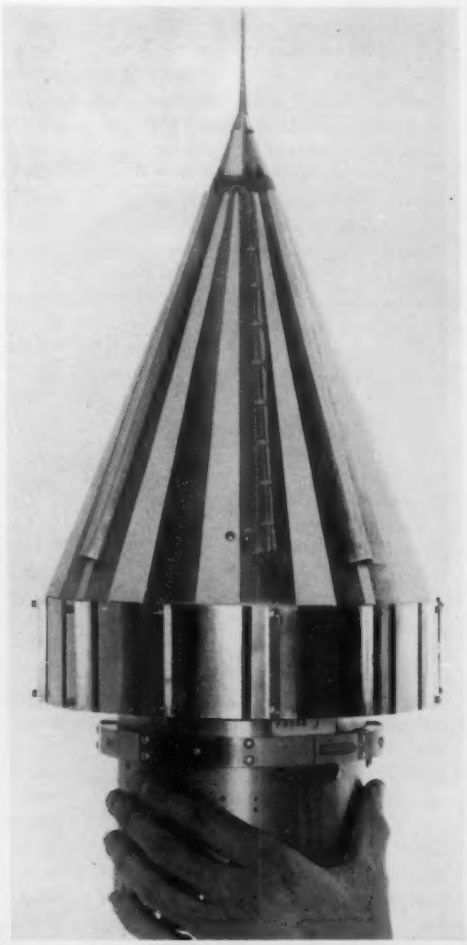
launching devices and as space probes. The incidence of total failure or minor malfunction in samples of small size can lead to conclusions which are of negligible significance in statistical terms. Reliability in complex, multistage rockets—particularly those using liquid fuels—is achieved only by painstaking effort during development. Progress is constantly being made in this respect, and there is every reason to expect that experience in the future will be appreciably better than it has been in the past. Nevertheless, it is also likely that failures will continue for some time to be a part of the cost of experimentation with high-performance rockets. While the problems of the reliability of the rocket and its controls are not the direct concern of the scientist engaged in space research, their implications should be borne in mind during consideration of the design of experimental apparatus so that the value of the experiment may not be entirely lost if the rocket fails to achieve the planned trajectory. Of course, the reliability of the experimental equipment itself is of the most vital concern to the scientist; this aspect is discussed below.

Weight and Volume

Limitations in the propulsion available for purely scientific purposes have, up to the present, restricted the scope of research with artificial satellites and space probes in this country. Useful weights of experimental apparatus have been less than 10 kilograms. Within the year, the availability of improved booster and upper-stage rockets should make possible increases in payload to more than 50 kilograms. In 1960, a still larger booster should permit the orbiting of earth satellites weighing 1000 to 2000







Analysis of the readings, obtained by telemetry, of the particle counters of Pioneer III together with earlier satellite observation led to the discovery of the two Van Allen radiation belts (shared areas) shown in the cross section (top left). The contours are drawn through points where the number of counts was 10, 100, 1000, and 10,000 per second. The ascending and descending segments of the trajectory of Pioneer III are superimposed [Courtesy State University of Iowa]. A view of the outside of the instrumented payload of the lunar probe Pioneer IV (right). The pattern of light and dark areas serves to stabilize the internal temperature by regulating the absorption and loss of energy from the sun. The probe Pioneer III was of similar construction [Courtesy U.S. Army]. The instrumentation of Pioneer IV (bottom left). The cylinders at the top are cosmic ray counters. The ring of cylindrical batteries below surrounds the telemetry transmitter. This device, protected by a housing similar to that at the right, is now in orbit around the sun. The instrumentation of the probe Pioneer III was similar except for the omission of the shielding around the counter on the left [Courtesy U.S. Army]. Both were constructed by the Jet Propulsion Laboratory of the California Institute of Technology.

kilograms. Improvements in upper stages are expected to make possible, in about 3 or 4 years, the launching of weights of several thousand kilograms into orbits of co-rotation with the earth (altitude of about 5.6 earth radii) or other accomplishments of comparable magnitude. Later still, very powerful rockets are likely to be available and, as the competence of the technology improves in this fashion, the determining factor in our space research work will then be scientific justification rather than engineering limitations.

For the immediate future, weight rather than volume appears to impose the greater restriction on the design of scientific satellite packages. For example, both Explorer and Vanguard satellites have carried most of their scientific equipment in cylindrical instrument compartments about 15 centimeters in diameter located along the spin axis. Instrument assemblies have taken the form of disk-shaped modules or decks of various heights, arranged in a stack. In the early Pioneers, on the other hand, the instrument packages were disposed around the equator of a top-shaped shell. Only in the Explorers was a substantial fraction of the total volume available occupied by the instruments.

Components and fabrication techniques similar to those used in miniaturized airborne and rocket electronic equipment have proved satisfactory for space use. Instruments requiring exterior surface mounting or bulky units of nonmodular dimensions can probably be accepted when the more powerful launching vehicles come into use.

Power

The electrical power supply carried by a space vehicle ordinarily determines the total amount of scientific data which can be acquired, amplified, and transmitted to the earth. Thus far, satellite and space probes have depended almost entirely upon chemical batteries (for example, mercury or silver-zinc cells), and these have usually functioned satisfactorily. A performance of about 100 watt-hours per kilogram of batteries has been obtained. On the average, power supplies of this kind have taken up about a quarter of the disposable weight in Explorer and Vanguard satellites.

In 1958 β, the small Vanguard test sphere, sufficient power was developed by banks of solar cells to operate a transistor transmitter at about 12 milliwatts. That this power supply has continued to operate satisfactorily since 17 March 1958 indicates that silicon solar cells are not rapidly damaged by the space environment. More extensive use of these cells in the future is expected. For the range of variation of aspect in an uncontrolled satellite, for storage of energy during periods when the cells may be in shadow, and for regulation and voltage conversion, about 2.5 kilograms are presently required for the supply of 1 watt. This is equivalent to more than 3000 watt-hours per kilogram, if a 1-year life is assumed. A 2.5 watt power system of this type will be used in a late IGY satellite.

Nuclear-powered devices are expected to provide efficiencies approaching 4000 watt-hours per kilogram for high-power, long-life applications in space vehicles. Although such systems are well advanced in development, some problems in application, in particular radiation shielding and heat dissipation, may present difficulties.

Recent American satellites have operated on batteries at a fractional watt level with lifetimes up to a few months (and one on solar cells for more than a year). Prospective space vehicles may operate at a few watts for periods up to a year. It may be expected that the 1960–62 period will see power levels of 50 to 100 watts.

Environmental Temperatures

The approximate solution of the problem of the temperature of a satellite or space vehicle was worked out prior to launching both for the Explorers and for Vanguard I. In both cases, temperature range reported from the satellite agreed with predictions within design limits. The temperature of the vehicle represents a balance between radiation absorbed by or heat generated within the satellite and the heat lost by radiation or latent heat exchange within the satellite. By suitable adjustment of the absorption and emission characteristics of the various portions of satellite surfaces, and with due consideration of the orbit, the shell temperature for Explorer I was held within a range of −25° to about 90°C. The corresponding temperatures within the shell are believed to have been 0° and 40°C. In Vanguard I, a stable temperature of about 40°C appears to have been reached within 1 day after launching.

Present techniques appear to be generally adequate for the design of instrument containers capable of maintaining temperature within tolerable limits. With some sacrifice of payload weight and diversion of power, more refined regulation of the temperature of the instrument compartment can be achieved.

Shock and Vibration

Once an instrument package has achieved orbit or a condition of coasting flight in space, it is essentially in a force-free condition except for the effects of residual spin, attitude control, or possible meteoritic impacts. In this environment, light-weight structures of large size may be erected—for example, by inflation. However, before this free-flight condition is attained the instrument package must withstand a great deal of shock and vibration. This occurs to some extent during shipment and preparation for flight but is more severe during the propulsive phases of launching when acceleration forces of both setback and spin are encountered, together with random vibration over a wide spectrum along all three axes.

For establishing flight dependability of the payload package, a program of shock and vibration testing has been developed in the IGY satellite program. Test limits are dictated in large measure by the shock and vibration characteristics of the payload itself. Specific test routines have been worked out for the Vanguard launching system, the Jupiter-C, the Pioneer, and the Juno II. These have included dynamic balancing, acceleration, spin tests, and triaxial vibration tests.

Although the severity of the tests differs somewhat for the various launching systems, the following, taken from the type approval tests for the Juno II prototype payloads, is illustrative of the conditions which some of the earlier experimental apparatus has had to withstand. These examples apply particularly to the lighter payloads; the requirements for resistance to shock and acceleration are likely to be somewhat less when heavier payloads are concerned.

1) Shock. The complete payload is subjected to about four 100g shocks parallel to the axis of the launching thrust.

2) Vibration. Random noise, 15g root-mean-square, parallel to the thrust axis for 2 minutes. Random noise, 12g root-mean-square, along two planes mutually orthogonal and perpendicular to the thrust axis for 2 minutes in each plane.

3) Static acceleration. The payload is

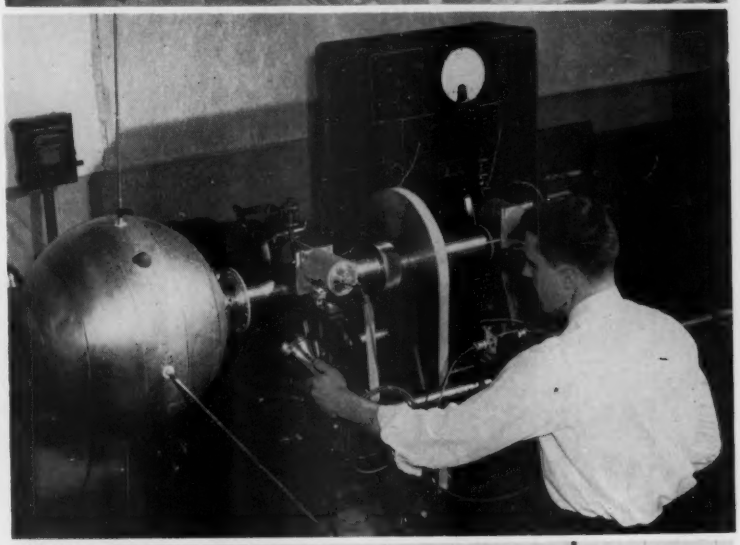
held at 75*g* for 2 minutes by centrifuging.

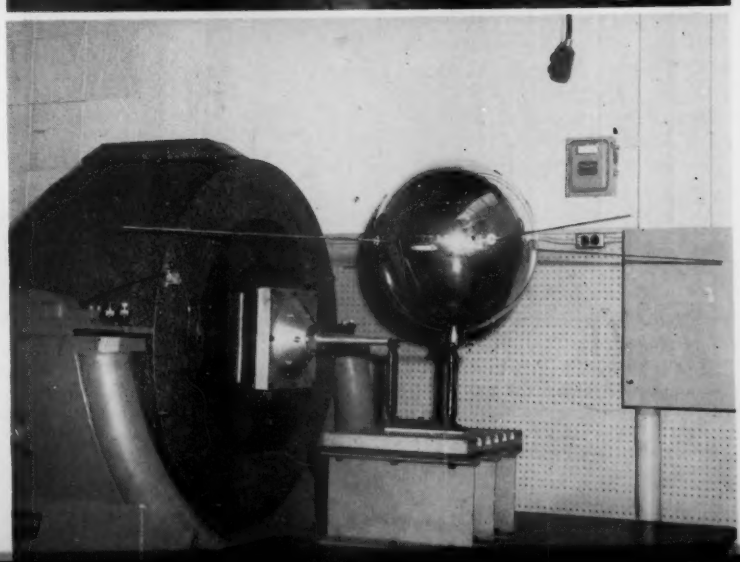
4) Spin. After dynamic balancing, the payload is spun at 900 revolutions per minute for 10 minutes.

The foregoing tests are applied to the flight prototype sample. Somewhat less rigorous flight acceptance tests are then applicable to identical payloads scheduled for actual flight.

The development of the payload instrument package for withstanding these and other physical conditions it is expected to encounter is the responsibility of an expert space-package design group having familiarity with the launch in question. Ideally, this group should begin to work with the scientist carrying out the experiment at an early phase of his instrument development, even before the completion of a laboratory bench model of the apparatus. After the individual components and the complete apparatus have been tested successfully for flight readiness, the flight-package engineers assume responsibility for adapting the approved instrumentation into a flight-prototype package which will meet environmental test requirements and which will be suitable for accommodation in the shell of the vehicle and, at the same time, functionally acceptable to the responsible scientists.

Massive test equipment is required for carrying out the full range of environmental tests for payload instrument packages, particularly for payloads of 50 kilograms or more. Adequate installations of test equipment are located at laboratories engaged in the development and design of airborne or space-vehicle instrumentation. These include NASA facilities at the Naval Research Laboratory, Washington, D.C.; the Jet Propulsion Laboratory at California Institute of Technology, Pasa-





Accelerations, vibrations, heating, and extremes of low pressure to which satellites and space probes are subjected during launch and free flight are severe. Preliminary systematic testing of the instrumented payloads under conditions which resemble those to be encountered later is essential. Examples of test equipment for this purpose are shown. (Top) A satellite is prepared for test in a vacuum chamber. The lamps visible inside the chamber are used to heat the satellite during the test cycle [Courtesy U.S. Navy]. (Middle) A satellite is observed while being rotated about its spin axis so that any residual dynamic unbalance can be found and corrected. [Courtesy U.S. Navy]. (Bottom) A satellite is mounted on a vibrational testing machine [Courtesy U. S. Navy].

dena; the Army Ballistic Missile Agency in Huntsville, Ala.; and the Air Force Ballistic Missile Division, Inglewood, Calif. Such test facilities have also been established by a number of major commercial contractors of NASA and the Department of Defense.

Telemetry

The transmission back to earth of instrument readings has been accomplished both with continuous transmissions and with storage of data and subsequent periodic "read-out" by radio command. Both phase and amplitude modulation have been used. Reception of a complete record for a satellite employing continuous telemetry requires an extensive network of receiving stations placed so that at least one is always within the line of sight of the satellite. Despite the severity of this requirement, excellent though not complete records have been obtained for U.S.-IGY satellites by this method.

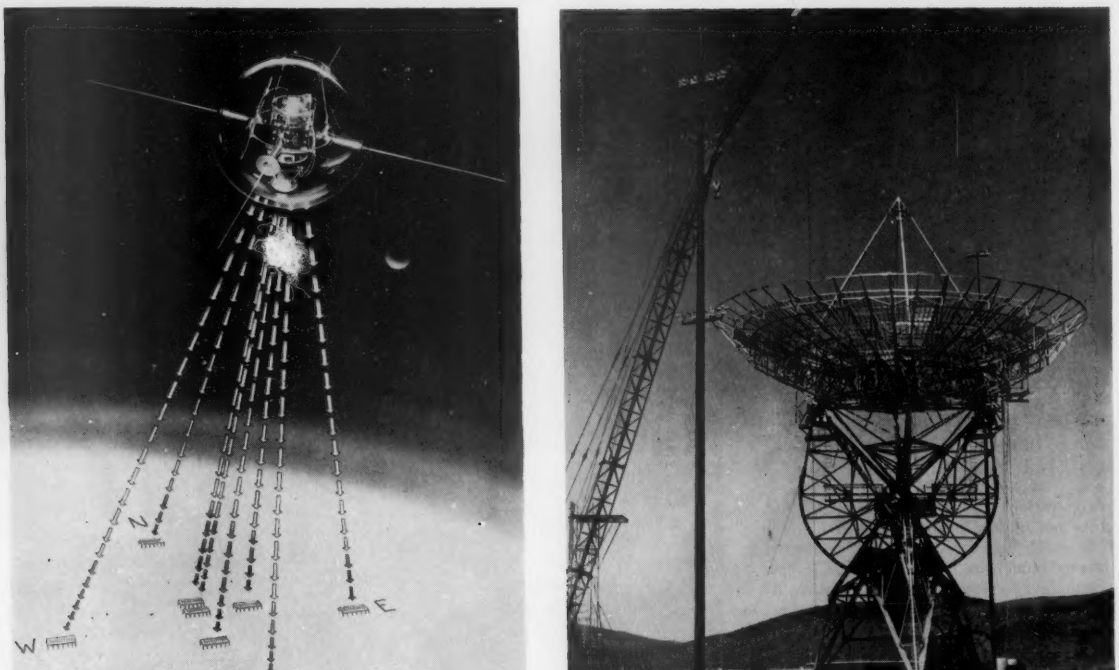
The alternate scheme, involving read-out of data upon command, was planned originally for the Vanguard satellites and was used successfully in Explorer III and Vanguard II. With the satellites containing a data-storage system sufficient for one orbit, it is possible for a complete record to be obtained from read-outs made once each orbit as the satellite passes over the "picket fence" array of tracking stations.

Satellite experiments in the U.S.-IGY effort have so far involved a communication rate of only a few cycles per second. Even when data gathered during a full revolution have been compressed for read-out transmission during passage over a tracking station, the communications bandwidth has not exceeded 15 kilocycles per second. Design of experiments for narrow-band signals was considered preferable not only because less power is required for such communication but also because the simpler design increases reliability.

As space science experiments become more complex, increased demands upon and improvements of telemetry capabilities may be expected. With the present state of the art, communications capabilities approach video bandwidths for ranges of several hundred miles. Limitations are of an engineering rather than a basic nature. Capability also exists for maintaining signal bandwidths of a few tens of cycles out to distances of the order of 100 earth radii and, according to the Jet Propulsion Laboratory, it should be possible by 1962 to communicate at 30-cycles-per-second bandwidth to a distance of about 1000 earth radii or to about one-tenth of that distance with a voice channel of 3 kilocycles per second.

Tracking

Facilities for tracking satellites by radio and optical means and for the computation of orbital position as a function of time have been established as a part of the U.S.-IGY program. These facilities are now being operated



IGY satellites are tracked by a network of radio interferometer stations. This diagram shows a typical arrangement of antenna pairs at such a station (left). Comparison of the phase differences between signals received at the various antennas from the satellite's transmitter establishes the position of the satellite [Courtesy Bendix Radio Corporation]. The 85-foot diameter trainable antenna of the Goldstone Tracking Station of the Jet Propulsion Laboratory is one of a group of radio telescopes used for tracking deep space probes (right). Devices of this sort are suitable for tracking objects in space so long as their angular rates are low. The same high-gain antennas also serve for receiving telemetry signals [Courtesy U.S. Army].

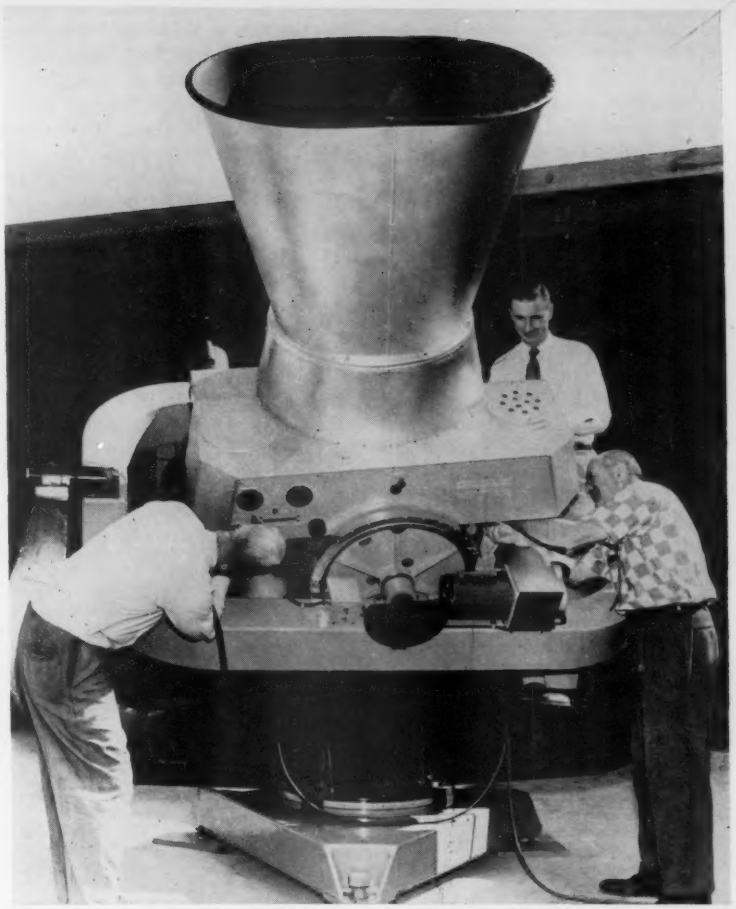
and expanded by the National Aeronautics and Space Administration.

The radio tracking network consists of interferometer stations, operating at 108 megacycles per second, at Blossom Point, Md.; Fort Myers, Fla.; Mt. Cotopaxi, near Quito, Ecuador; Lima, Peru; Antofagasta and Santiago, Chile; San Diego, Calif.; Woomera, Australia; Antigua, British West Indies; and Esselen Park, South Africa. These stations are also equipped for command read-out of telemetry. Some are also equipped for tracking at 40 megacycles per second. Another group of stations, primarily for reception of telemetry and disposed for wider longitudinal coverage, includes sites at San Gabriel and Earthquake Valley, California.; Cape Canaveral, Fla.; Huntsville, Ala.; White Sands, N.M.; Ibadan, Nigeria; and Singapore. Arrangements have been made for enlisting the aid of the Jodrell Bank Experimental Station in England for the tracking of deep space probes, and three smaller radio telescopes, to operate as a group, are also being set up for this purpose. The first of these is at Goldstone, California. A number of additional radar and space vehicle reception stations has also been put in operation by the Department of Defense.

Precise observations suitable for the computation of definitive orbits for satellites are made by the IGY optical tracking network, now operated by the National Aeronautics and Space Administration and the Smithsonian Astrophysical Observatory. This network includes the following stations, each equipped with an F: 1, 20-inch photo telescope: White Sands, N.M.; Florida, near Palm Beach; Curacao, Netherlands West Indies; Arequipa, Peru; Villa Dolores, Argentina; Olifantsfontein, South Africa; Cadiz, Spain; Shiraz, Iran; Naini Tal, India; Woomera, Australia; Mitaka, Japan; Haleakala, Maui, Hawaii.

Plans for the centralized reduction and compilation of both telemetry and orbital data are under study by the National Aeronautics and Space Administration. In the meantime, it is customary to provide the experimenter with magnetic tape records of the telemetry signals in the form in which they are received.

Orbital data provide a correlation of scientific data with the position of the instrument package in space. These data can be furnished to the scientist as a tabulation of co-ordinates or orbital subpoints and vehicle altitude, given at specified instants of time. At present, the uncertainty of the positions in space so defined is somewhat less than 10 kilometers. For experiments requiring higher precision, improvement is undoubtedly possible.



The Baker-Nunn IGY satellite tracking camera shown here is one of 12 installed on a world-wide basis for photographing artificial satellites against the star background. Accurately timed photographs from these cameras, collated and reduced by the Smithsonian Astrophysical Observatory, have assisted in establishing definitive orbits for even the smallest satellites. The 15-centimeter sphere 1958β2 has been photographed repeatedly at various distances and by the Australian station at Woomera at the extreme range of nearly 4000 kilometers. [Courtesy Smithsonian Astrophysical Observatory]

Space Science Board

The establishment of the Space Science Board of the National Academy of Sciences was announced on 2 August 1958, by Detlev W. Bronk, president of the Academy. The purpose of this board is, in the broadest terms, to ensure the constructive support of the scientific community for a sound and imaginative program of scientific research in space. On the domestic scene, its functions in this regard are to be the focus of the interests and advisory responsibilities of the Academy-Research Council in space science; to draw the attention of scientists to the problems and opportunities in space research, and to provide advice as they may require. In international scientific affairs, the board acts as the instrument for collaboration with the International Council of Scientific Unions and serves thereby to promote the cooperation of American scientists with international programs of space research.

It was noted at the time of its establishment that, in conformity with the academy's tradition, the Space Science Board would function solely in an advisory capacity. Provision for the operational aspects of the conduct and support of space research has been made by law in the establishment of the gov-

ernment agencies cited above. It is clear also that the board's advisory functions must be of a dual nature: it must serve not only the needs of government but also the needs of the scientific community by giving audience to and advice on the problems and suggestions of individual scientists and research institutions.

At the time of the board's formation, the National Aeronautics and Space Administration had not yet come formally into existence. In order to assist in the formulation of the beginnings of a sound research program the board took the initiative of soliciting proposals and suggestions for research in space, a task which had already been recognized and begun by the Satellite Panel of the academy's IGY Committee. The widespread response to these requests provided the basis for a series of recommendations for a beginning research program. It is gratifying to note that these recommendations have, essentially in their entirety, been incorporated into the research program of the National Aeronautics and Space Administration. In view of the success of these initial endeavors and the rapidly developing strength and competence of the National Aeronautics and Space Administration, the board now feels free to devote its efforts more particularly to the consideration of the longer-term problems in space research, to study the support which space research may require in the future from other related branches of fundamental scientific enquiry, and to examine the problems of individual research workers in universities and elsewhere.

In the discharge of these responsibilities the board expects, in addition to its regular meetings and those of its component committees, to arrange and sponsor a series of open meetings and symposia on special problems in space research. The first of these was held in Washington during the meeting of the National Academy of Sciences in April of this year under joint sponsorship with the American Physical Society and the National Aeronautics and Space Administration. Special reports on scientific aspects of space exploration will also be published from time to time; the first of these is due for publication in a few months.

The board's membership consists of the following: L. V. Berkner (chairman), H. S. Brown, Leo Goldberg, H. K. Hartline, D. F. Hornig, W. A. Noyes, Jr., R. W. Porter, B. B. Rossi, A. H. Shapley, J. A. Simpson, S. S. Stevens, H. C. Urey, J. A. Van Allen, O. G. Villard, Jr., Harry Wexler, G. P. Woollard, Hugh Odishaw (executive director), and R. C. Peavey (secretary). The board has established the following 12 committees to deal with particular aspects of space science.

Committee 1, Chemistry of Space and Exploration of Moon and Planets: H. C. Urey (chairman), H. S. Brown (vice-chairman), Harmon Craig, Mark Inghram, Frank Press, G. de Vaucouleurs, F. L. Whipple, H. F. York, H. H. Hess, G. A. Derbyshire (secretary)

Committee 2, Optical and Radio Astronomy: Leo Goldberg (chairman), L. H. Aller, H. W. Babcock, A. D. Code, J. W. Evans, John Findlay, Herbert Friedman, Roger Gallet, F. T. Haddock, Jr., Lyman Spitzer, Jr., Martin Schwarzschild (Alt.), Otto Struve, E. R. Dyer (secretary)

Committee 3, Future Vehicular Development: D. F. Hornig (chairman), Abe Silverstein, J. P. T. Pearman (secretary)

Committee 4, International Relations: R. W. Porter (chairman), W. O. Fenn, H. E. Newell, Jr., H. P. Robertson, A. W. Frutkin (secretary)

Committee 5, Immediate Problems: R. W. Porter (chairman), G. A. Derbyshire (secretary)

Committee 6, Space Projects: B. B. Rossi (chairman), Thomas Gold, S. E. Luria, Philip Morrison, J. P. T. Pearman (secretary)

Committee 7, The Ionospheres of the Earth and Planets: A. H. Shapley (chairman), H. G. Booker, J. W. Chamberlain, Robert Jastrow, C. G. Little, Laurence A. Manning, R. C. Peavey (secretary)

Committee 8, Physics of Fields and Particles in Space: J. A. Simpson (chairman), J. A. Van Allen (vice-chairman), J. W. Chamberlain, William Kraushaar, E. N. Parker, E. H. Vestine, John Winckler, Stanley Ruttenberg (secretary)

Committee 9, General Engineering Service and Co-ordination: O. G. Villard, Jr. (chairman), E. C. Buckley, J. P. T. Pearman (secretary)

Committee 10, Meteorological Aspects of Satellites: H. W. Wexler (chairman), C. C. Bates, George Benton, E. M. Cortright, Sigmund Fritz, W. W. Kellogg, Norman Phillips, Ernst Stuhlinger, V. E. Suomi, W. K. Widger, Jr., E. R. Dyer (secretary)

Committee 11, Psychological and Biological Research: H. K. Hartline (chairman), S. S. Stevens (vice-chairman), H. J. Curtis, L. E. Farr, Joshua Lederberg, E. F. MacNichol, Otto Schmitt, E. L. Tatum, G. A. Derbyshire (secretary)

Committee 12, Geodesy: G. P. Woollard (chairman), Paul Herget, R. K. C. Johns, D. A. Lautman, William Markowitz, J. A. O'Keefe, W. J. O'Sullivan, D. A. Rice, Hellmut Schmid, C. A. Whitten, E. R. Dyer (secretary)

International Cooperation

On the international scene, the Committee on Space Research (COSPAR) was established by resolution of the International Council of Scientific Unions in October of 1958. The function of this committee is to assist in the advancement on an international scale of fundamental research carried out with the use of rockets or rocket propelled vehicles. The membership includes representatives of the appropriate international scientific unions, the scientific institutions of those countries having satellite or other space research programs, and others having special interests in space science. The Space Science Board, in its international role, represents the interests of the Academy and the American scientific community on COSPAR.

Three working groups have been established by COSPAR to study, respectively, (i) tracking and telemetry, (ii) proposals for scientific experiments and research programs, and (iii) arrangements and methods for exchange and publication of data. In addition, the functions of the ICSU Committee on Contamination by Extra-terrestrial Exploration (CETEX), which had been established before COSPAR came into existence, have now been transferred to COSPAR.

In essence, COSPAR provides a means for continuation of the cooperative IGY programs of rocket and satellite research. It is to be hoped that this committee will be able not only to carry on but also to broaden and intensify the fruitful scientific relations which characterized the IGY programs.

Poleward Migration of Early Angiosperm Flora

Angiosperms only displaced the relict Jurassic-type flora at high latitudes in Late Cretaceous time.

Daniel I. Axelrod

Cretaceous floras record one of the major events in the biological history of the earth: the transformation from a world dominated by typically Jurassic-type ferns, seed ferns, and gymnosperms early in the period to a later Cretaceous landscape in which flowering plants of near-modern type were characteristic and world-wide in their distribution. This change in vegetation raises many problems for consideration, one of which pertains to the geographic center of origin of the group. The widely divergent opinions regarding this problem are evident in viewpoints which have favored temperate Holarctica (*1*), the Southern Hemisphere (*2*), Antarctica (*3*), the ancient tropical belt (*4*), and Southeast Asia (*5*) as the general area of early angiosperm evolution. I recently reexamined these ideas while preparing a review paper on the evolution of flowering plants in which attention was directed chiefly to the origin and evolution of present-day distribution patterns. As an outcome of this analysis, additional evidence was uncovered which strengthens the view that flowering plants evolved in tropical regions during pre-Cretaceous time. To avoid any possible confusion, it must be emphasized that this ancient tropical belt—which appears to reflect the normal climate of most of geologic time—was quite extensive. To judge from the paleoclimatic implications of fossil plants, the belt extended at least to latitudes 45°N and 45°S from the Permian into the Cretaceous, the interval during which angiosperms appear to have been evolving prior to their first occurrence in abundance (*4*).

The evidence supporting the belief that flowering plants originated in this broad tropical belt during pre-Cretaceous time is provided by the spatial relations of the earliest floras that contain angiosperms. The spatial relations seem to show that flowering plants first entered the lowland record within the tropical belt at lower middle latitudes at the beginning of the Early Cretaceous, that they reached high latitudes late in the epoch, and that with few exceptions they became dominant there only in Late Cretaceous time. In this article, the evidence which appears to demonstrate this relation is summarized first, and then its implications are outlined.

Early Cretaceous Sequences

In order to present concisely and clearly only the significant data which bear on the problem, the floras have been grouped according to the five major regions where they occur in sufficient number to warrant consideration. For each area a diagram has been prepared in which the floras are plotted according to latitude, age, and angiosperm content (Figs. 1–5). The curve in each figure represents an approximate time line that largely separates floras with no angiosperms (below) from those with them (above). The percentage of angiosperms shown for each flora is not precise because some of the floras need taxonomic revision and others are based on an inadequate number of samples. However, the critical point is not the exact percentage but the relative abundance—whether they are rare (less than 10 percent), moderately common (10 to 30 percent), common (30 to 60 percent), abundant (60 to 80 percent), or predominant (over 80 percent).

With respect to the age assignment of the floras shown in the figures, those marked with an asterisk occur in sections that interfinger with the marine Cretaceous rocks which have been zoned chiefly on the basis of ammonites. Thus, they afford a relatively sound basis for determining the essential contemporaneity of sedimentary units and their contained fossils in widely separated parts of the world; current research on marine Cretaceous microfossils (foraminifera, discoasterids) has largely substantiated and further refined the correlations made on the basis of the megafaunas. A number of the remaining floras (marked by a dagger in the figures) are reasonably well fixed in time on the basis of their occurrence in stratigraphic sections which are dated either by vertebrate or by marine faunas.

North American region (Fig. 1). The oldest floras containing angiosperms are the Patuxent of Maryland-Virginia and the Lower Horsetown of California. Floras of generally similar age at higher latitudes, such as the Kootenai of Montana, Alberta, and the British Columbia, the Nikanassin of Alberta and British Columbia, and the Tantalus from Yukon Territory, Canada, are not now known to contain flowering plants. Angiosperms do not appear in Canada until Aptian time, when they make up only 1 to 2 percent of the Lower Blairmore and Gething floras. At the same time, however, the angiosperm content of floras at lower latitudes had increased, as shown by the Funson (45 percent) of Wyoming; even the older Arundel of Maryland has 25 percent angiosperms. A predominant Jurassic aspect was maintained by the floras at higher latitudes well into the Albian stage, as illustrated by the Kennicott flora of south-central Alaska and by the Corwin flora from the arctic seacoast of Alaska, neither of which is now known to contain flowering plants. By contrast, floras of similar age at middle latitudes—for instance the Upper Blairmore (40 percent) and Cheyenne (50 percent)—have a prominent angiosperm content.

These relations show that, in general, angiosperms entered lowland areas at higher latitudes in rocks of successively younger age and only displaced the relict Jurassic vegetation there during the Late Cretaceous.

Northeast Asian region (Fig. 2). Angiosperms have not yet been described from the numerous floras of Neocomian age that are known in northeastern Asia.

The author is on the staff of the department of geology, University of California, Los Angeles.

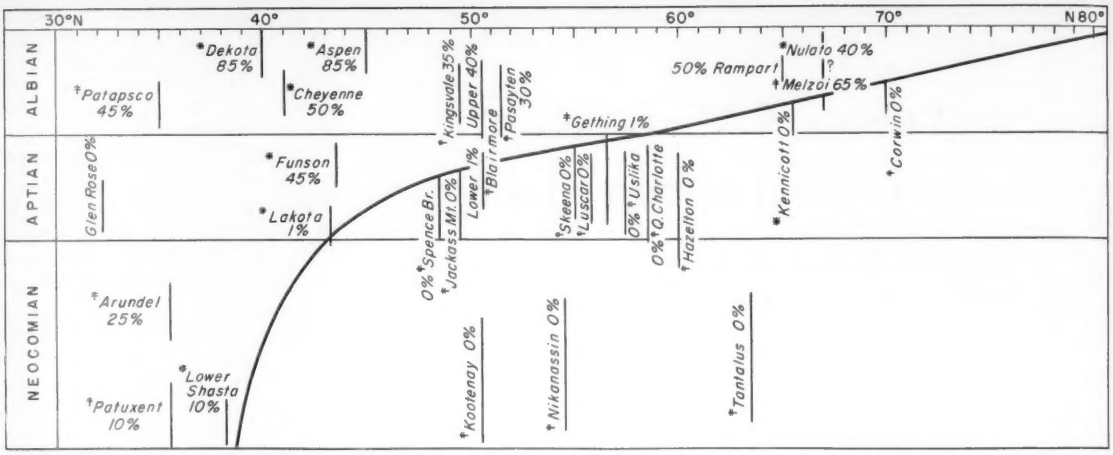


Fig. 1. North American region. Time-space relations of Early Cretaceous floras and the percentage of angiosperms they contain.

They first appear in the Aptian of Ussuriland (Suchan). By Albian time they made up nearly 45 percent of the Upper Keisho flora of Korea, but at higher latitudes in Siberia, Albian floras contain few members of the alliance. As in Alaska and Greenland, the delayed appearance of angiosperms in the lowland floras of northeast Asia is reflected in the fact that even the mid-Cretaceous (Cenomanian-Turonian) floras of the region rarely contain more than 40 percent angiosperms. Thus, the Yezo flora of Hokkaido has approximately 40 percent flowering plants; the Gyliakian of northern Sakhalin, 30 percent; and the Pekuleni of Anadyrland, 20 percent.

Although the evidence is less complete than for North America, it suggests that angiosperms gradually invaded higher latitudes from more southerly areas during the Early Cretaceous, and that northern Siberia was a refuge for remnants of the Jurassic flora well into the Late Cretaceous, a view expressed earlier by Vakhrameev (*6*).

West European region (Fig. 3). The general time-space relations of the more important Early Cretaceous floras show that angiosperms were represented in Portugal during the Neocomian. However, contemporaneous floras to northward, such as the Wealden of England, France, Belgium, and adjacent areas, do not contain them, nor are they represented in the floras from Spitzbergen, Franz Josef Land, the King Karl Island in the Arctic Ocean. During Aptian time the floras of Portugal contained 25 percent angiosperms, but angiosperms are less abundant in the Greensand of England, where they are represented only by wood, which probably was carried into the lowland basin from bordering highlands. To the northward, the Aptian floras of Klin, U.S.S.R., and Pattorfik, Greenland, do not contain angiosperms.

The Kome flora of Greenland, with 10 percent angiosperms, was once considered to be the oldest Cretaceous flora containing flowering plants. This led Seward, Berry, and others to champion the idea that flowering plants had their origin in high northern latitudes from which they gradually spread southward during the Cretaceous. More recent evidence indicates that the Kome is relatively high in the Early Cretaceous, and that it may be as young as Albian (*7*). Such an assignment is wholly consistent with the time-space relations of angiosperms in the well-dated Albian floras of Alaska and northeastern Siberia discussed above, and on this basis the Kome is here assigned an Albian age (Fig. 3). Such an assignment is consistent with the persistence of a dominant (55 to 60 percent) Jurassic-type element into the Late Cretaceous (Turonian, Campanian) Atane and Patoot floras of Greenland. By contrast, floras of similar and of even greater age (Cenomanian, Albian) at lower latitudes in Europe and North America are preponderantly angiospermous.

These relations support the thesis that angiosperms were migrating northward during the Cretaceous, and that they only displaced the older Jurassic-type vegetation at high latitudes during the Late Cretaceous.

Australia–New Zealand region. (Fig. 4). Angiosperms are not now known in floras of Neocomian age in the Australia–New Zealand region. They first appear in Australia in the Styx River and Winton floras of transitional Aptian-Albian age. The evidence in New Zealand, as revealed chiefly by recent pollen studies, shows that flowering plants entered the record there only in Albian time. The small flora from Kaipara, New Zealand, associated with ammonites of Turonian age, indicates that a Jurassic-type floral element was dominant well into mid-Cretaceous time in the lowlands of the region, much as it was in northern Alaska, Greenland, and Siberia.

The data are still incomplete, it is true, but the results to date agree with those indicated for the other regions discussed above.

South American region (Fig. 5). At the present time only a few floras are known from South America, yet they are sufficiently significant to warrant comment. The Lago San Martin flora, which has strong Jurassic affinities and was assigned to the Neocomian with considerable reservation by Halle, is now known, on the basis of associated ammonites, to overlap the Aptian-Albian boundary. The older floras of the region, apparently Neocomian, do not contain flowering plants. The data thus show that angiosperms did not invade the lowlands of southern Patagonia (latitude 45°S) until late in the Early Cretaceous (Albian), when they were also appearing in New Zealand at a comparable latitude.

This evidence leads to the inference that Jurassic-type vegetation persisted at high southern latitudes well into the Late Cretaceous, much as it did in the Northern Hemisphere.

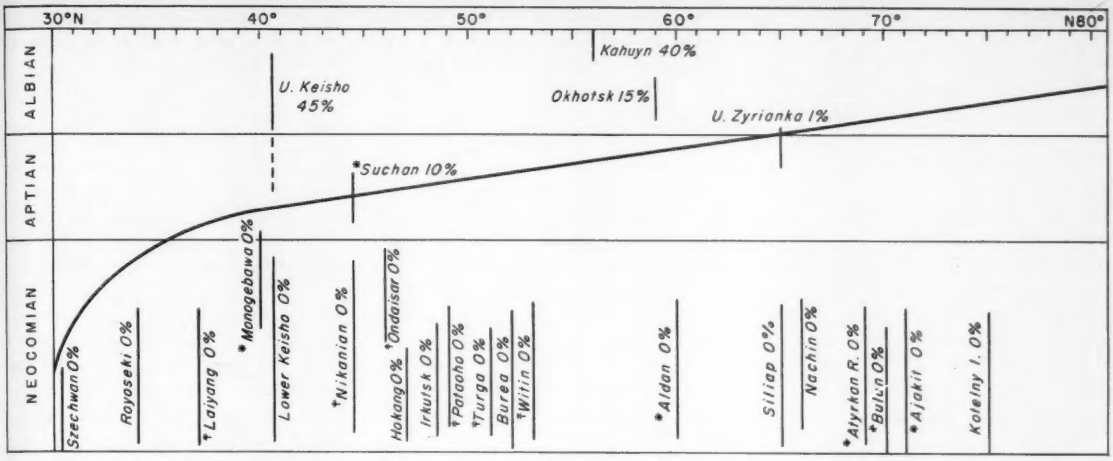


Fig. 2. Northeast Asian region. Time-space relations of Early Cretaceous floras and the percentage of angiosperms they contain.

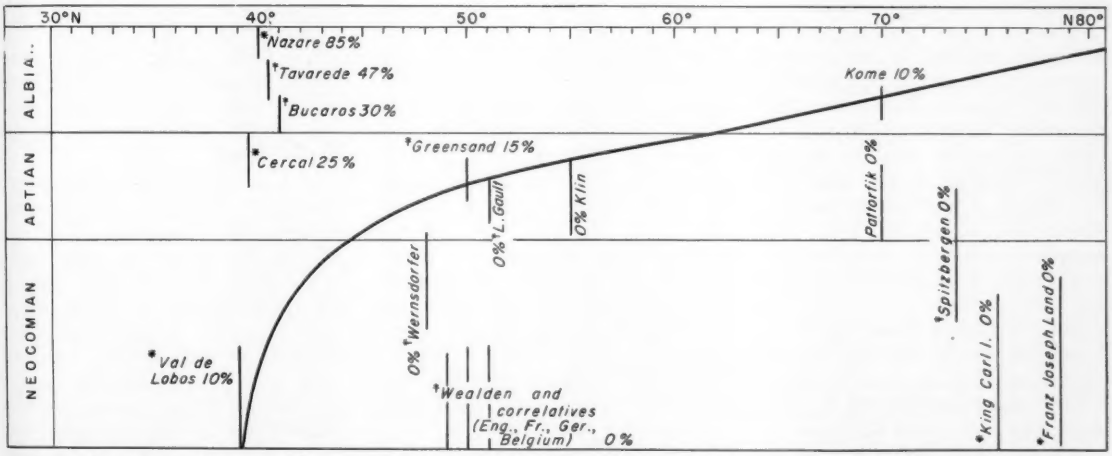


Fig. 3. West European region. Time-space relations of Early Cretaceous floras and the percentage of angiosperms they contain.

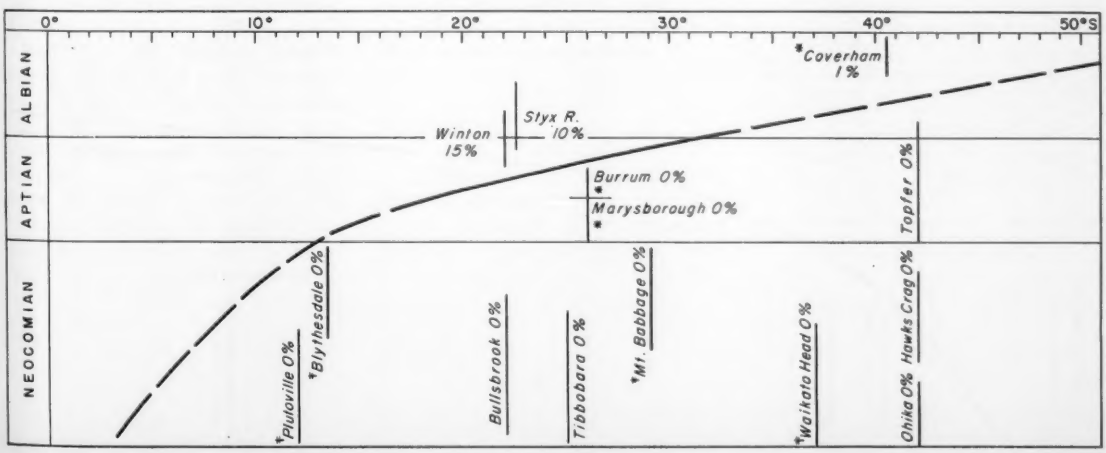


Fig. 4. Australia-New Zealand region. Time-space relations of Early Cretaceous floras and the percentage of angiosperms they contain.

Discussion

Available evidence for all regions thus indicates that angiosperms initially invaded lowland basins at generally lower latitudes and appeared in the record at higher latitudes only in the later part of the Early Cretaceous. Even by mid-Cretaceous (Cenomanian-Turonian) time, many high-latitude floras still had a prominent relict Jurassic element (more than 50 percent), whereas floras at lower latitudes were preponderantly angiospermous. This poleward migration of angiosperms during Early Cretaceous time can best be explained on the assumption that angiosperms evolved within the ancient tropical belt (latitudes 45°N to 45°S). With such a center of origin, it naturally follows that flowering plants would appear first in the record at lower latitudes and enter the lowland basins of higher latitudes at a later time. This conclusion, based on the time-space relations of angiosperms, agrees with both distributional and evolutionary evidence provided by Late Cretaceous and Cenozoic flowering plants, which also suggests that the phylum evolved within the tropical zone (*4*). The absence of angiosperms from the record there in pre-Cretaceous time seems chiefly due to the fact that they were confined to upland areas earlier in their history.

Several important factors appear to account for the fact that angiosperms did not invade the lowlands at a given latitude simultaneously during any particular stage of the Early Cretaceous.

1) If angiosperms were evolving in upland areas prior to the Cretaceous, they would have initially entered lowland basins situated near mountainous tracts. This seems to explain their early appearance at lower middle latitudes in California, Maryland, and Portugal. Conversely, lowland basins situated in nearly level regions generally remote from upland angiosperm populations were invaded at a somewhat later date. Such a relation may explain, at least in part, their apparent absence from the Neocomian floras of such tropical regions as India, northern Australia, central Africa, and Venezuela; available evidence indicates that the sedimentary basins of these regions were situated in low-lying tracts generally remote from areas of high relief.

2) An edaphic factor may account for their delayed appearance in the lowland record in some regions. Many of the Early Cretaceous basins which have yielded fossil floras were typified by conditions favorable for coal formation. These swampy lowland basins were dominated by ferns, seed ferns, and various gymnosperms which were highly adapted to such environments. By contrast, flowering plants were evolving chiefly in well-drained, upland regions and only became adapted to swampy sites secondarily. Thus, their late appearance in lowland areas in some basins, even though these basins were bordered by uplands, may have been due to the persistence of swampy sites of wide extent which they could not yet invade. Future pollen studies in such basins may reveal that flowering plants actually were present in the nearby highlands.

3) Favorable relict sites probably enabled the older Jurassic-type vegetation to persist for a somewhat longer interval in some areas, much as the Tropical-Tertiary geofloras lingered on the west coasts of the northern continents at middle latitudes into the Late Miocene.

4) The factors involving transport and preservation may explain the absence of angiosperms from the record in some cases. For example, the Aptian Glen Rose flora of Texas is preserved in the marine Glen Rose limestone. The plant collection represents drifted material composed chiefly of structures well suited to transport, such as stems, twigs, and cones. Thus, it is possible that angiosperms, which were only moderately common at this latitude (32°N) during the Aptian, did not survive transport to this marine site of deposition. This would be particularly true if the low, swampy shores (coal is found in the section) were dominated by coniferophytes, cycadophytes, and ferns which were persisting in a favorable relict site, and if flowering plants were on more distant, well-drained slopes sufficiently remote—perhaps only a few miles away—to preclude their occurrence in the marine section.

5) A combination of these factors may also explain the slightly different times of appearance of angiosperms in the record in a given region. For instance, some of the Albian floras of Alaska (see 7) are reported to occur in well-dated marine sections, but the percentage of angiosperms in them deviates from the idealized curve in the diagram (Fig. 1). We must not forget, however, that this region is very complex structurally, that the sections are incompletely exposed, and that many of the collections were

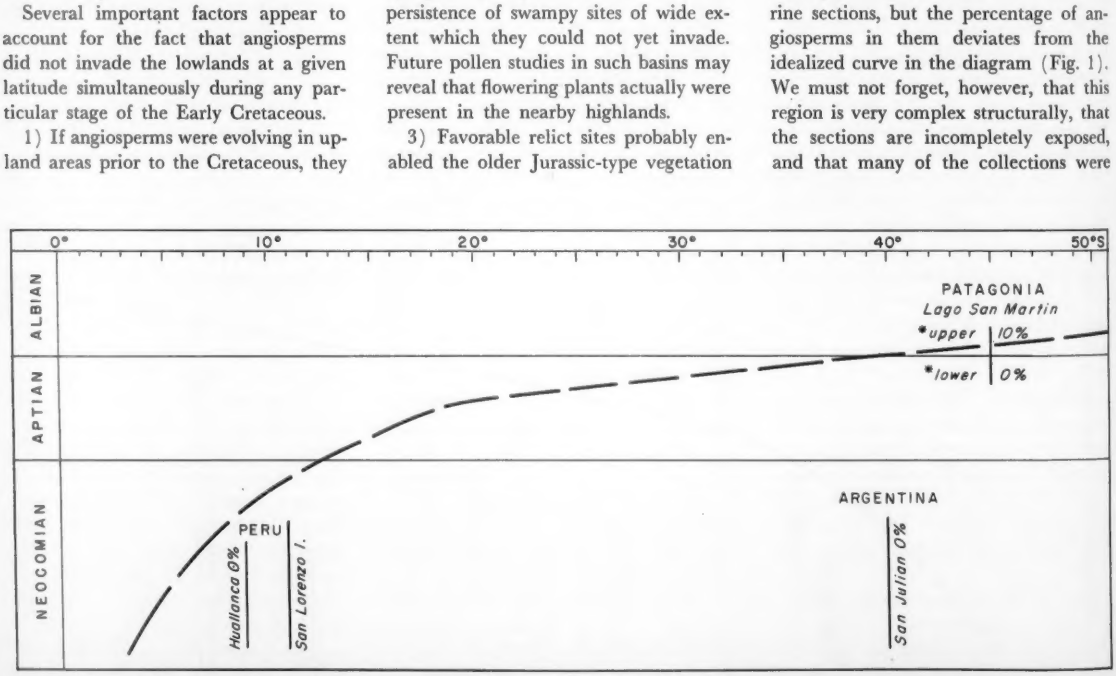


Fig. 5. South American region. Time-space relations of Early Cretaceous floras and the percentage of angiosperms they contain.

secured by early reconnaissance expeditions. Thus, some of these Alaskan floras may actually have stratigraphic positions other than those to which they have been assigned. Pertinently, Martin (*8*) notes that some of the marine fossils may come from older rocks which were erroneously correlated with the plant-bearing beds.

These limitations, as well as the general scarcity of fossil floras in the Southern Hemisphere, must be taken into account, but the evidence nonetheless suggests that, for a given stage, angiosperms had penetrated farther north than south. For instance, they are represented in the Neocomian of California, Virginia, and Portugal, but no Neocomian flora now known from the Southern Hemisphere contains them. Similarly, during the Aptian they had ranged northward to latitude 50°N in Ussuriland, western Canada, and England, yet in the Southern Hemisphere they occurred only at low latitudes during this stage.

Furthermore, whereas angiosperms had reached latitude 70°N in the Albian (Greenland, northern Alaska, northern Siberia), they were only commencing to appear at middle latitudes (45°S) in the Southern Hemisphere (New Zealand, Patagonia) at this time. By contrast, at middle latitudes in the Northern Hemisphere, most Albian floras have a dominant angiosperm element. These geographic relations are sufficiently striking to suggest that flowering plants may have evolved chiefly in the tropical parts of the Northern Hemisphere. However, since angiosperms may already have been in existence in upland areas by the Permian (*4*), and because the record of the group is exceedingly fragmentary into the Early Cretaceous, the data obviously do not permit us to suggest any one area as the cradle of origin.

Apart from these relationships, which indicate that flowering plants evolved in generally tropical latitudes, the evidence demonstrates that age analysis of Early Cretaceous floras must take into account time-space relations analogous to those shown by Tertiary forests (*9*). The numerous differences in apparent age which have existed for nearly a century as deduced from the testimony of fossil plants and from that of marine invertebrates—often recovered from the same section—seem chiefly due to the fact that the time-space factor has not previously been considered by paleobotanists. As we have seen, typically Jurassic-type vegetation persisted in scarcely modified form at high northern and middle southern latitudes well into the closing stage (Albian) of the Early Cretaceous. This survival clearly accounts for Knowlton's (*10*) assignment of the Corwin flora from the Arctic seacoast of Alaska to the Jurassic, though recent evidence shows that the plant-bearing beds overlie conformably a marine section containing later Albian ammonites (*11*).

Similarly, we can now understand Halle's (*12*) uncertainty over the age of the Lago San Martin flora from Patagonia. Halle felt that it was Jurassic but assigned it to the Early Cretaceous (Neocomian) because fragments of Cretaceous-type ammonites were found in the section; more recent collections show that these marine fossils are transitional Aptian-Albian (*13*). Arber (*14*) also noted the Jurassic character of the flora from Waikato Head, New Zealand, but pronounced it Neocomian because two species of angiosperms were included in the collection. We now know that the specimens studied by Arber were mixed from two different localities and that the angiosperms are from much younger rocks (*15*); further, the Waikato Head flora apparently is underlain by rocks of Neocomian age. Lastly, we may recall that the floras from Spitzbergen, Franz Josef Land, King Karl Island, and Kotelny Island in the Arctic Ocean, as well as many of those in arctic Siberia, originally were assigned to the Jurassic, though they occur in sections which yield Cretaceous marine invertebrates (*16*).

Summary

1) During the opening phase of the Early Cretaceous (Neocomian), angiosperms commenced to invade lowland basins of deposition at generally lower latitudes. They reached high northern and middle southern latitudes at the close of the epoch (Albian) and only replaced the relict Jurassic-type vegetation at high latitudes during the early part of Late Cretaceous time.

2) This poleward migration of angiosperms is consistent with the theory that the phylum had its center of origin and dispersal at tropical latitudes, which ranged between 45°N and 45°S in pre-Cretaceous time.

3) Recognition of the time-space factor involved in the Early Cretaceous poleward migration of angiosperms removes most of the conflicts in the testimony on age supplied by fossil plants and by marine invertebrates—conflicts which have persisted for nearly a century (*17*).

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News of Science

Decentralized Science Plan Approved by Soviet Academy

Soviet scientific research, until recently rigidly directed by a central agency, will be decentralized to a greater extent in the future. Only a small number of the most important programs, such as those concerned with controlled fusion and space exploration, will remain under strong central control. Planning and administrative authority for most other programs and projects will be transferred to the research institutes that actually do the work. This change, which resulted from the recent annual meeting of the Soviet Academy of Sciences, reflects a major shift in Soviet policy. Previous policy statements of the academy have stressed the need for centralized direction of science.

Behind these changes is the recent adoption by the academy of a new constitution, which is said to be more democratic than the one it replaces, which dates back to 1935. News of the new constitution was made public in a recent issue of *Vestnik,* the official organ of the academy. The new document and the changes it calls for were endorsed by V. A. Kirillin, head of the Communist Party's science division.

In addition to fusion and space activities, high-temperature metallurgical research, advanced computer developments, and certain areas of chemistry will remain under central direction, according to A. N. Nesmeyanov, president of the academy. However, the presidium, the directing body of the academy, which at one time had, in effect, complete authority over planning of the most important scientific projects, will now be joined by other groups in exercising this function. Authority to develop projects other than the 30 or so "high-priority" ones which will be listed in a document titled "Basic Directions of Scientific Research in the U.S.S.R. will be transferred to the various research centers, of which there are about 1000.

Centralization Attacked

In a news article in *Pravda,* Kirillin combined approval of the new changes with an attack on past practices in Soviet science management. "It would be difficult to imagine," he said, "that any one central institution, even if it had the most qualified people, could study competently and in a short time the vast amount of material that it would receive from all the scientific organizations." The idea that this could be done, he said, should be rejected at once. The proper function of the central institution that until recently had this role—the Academy of Sciences—is pointedly stressed in the new constitution. The academy is "directly subordinate to the Council of Ministers of the U.S.S.R. to which it submits an annual report of its activities." A number of old practices of the academy have been changed or abolished. New members will be elected annually, rather than irregularly as in the past. There will be no more honorary members, and all future members will have to be working scientists. Meetings of the academy's general assembly will have to be held at least twice a year.

Plan Reverses 1950 Move

The new constitution is apparently designed to give greater autonomy to the many research institutes scattered around the country. It is an attempt, according to some commentators, to achieve actual democratic operation in matters concerned with all but the most critical research programs. The commentators, however, point out that the 1935 constitution was also nominally democratic but that the academy in fact controlled all scientific programs in disregard of the charter. How the new move will succeed is anyone's guess. One point can be made, however. The plan that was revealed by *Vestnik* represents a major and surprising shift in Soviet policy. Just 9 years ago, according to one student of Soviet organization, the trend was in exactly the opposite direction. The scholar Alexander Vucinich, a research associate at the Hoover Institute at Stanford University, wrote in his study *The Soviet Academy of Sciences,* published in 1956, that "prior to 1950 there was considerable room left for both unplanned research and so-called intrainstitute planning, both of which allowed scholars to participate, at least on a part-time basis, in self-initiated research. Since 1950, an intensive campaign has been under way to eliminate all the areas of independent research and subordinate everything to the plan."

Satellite Systems Proposed To Detect Atom Blasts in Space

Scientists representing the three nuclear powers at Geneva have recommended that one of three satellite systems be used to detect atomic blasts in space. The recommendations, if accepted by the United States, Great Britain, and Russia, would become part of a general treaty for a ban on testing nuclear weapons. Negotiations on such a treaty have been under way since last October.

The new proposals, if accepted, would be the basis for a critical detection net which would be used to assure that there would be no violations of a test ban. Controversy over the feasibility of effective controls has been one of the major stumbling blocks of the long-drawn-out Geneva talks.

Under the proposals, satellites weighing several thousand pounds would be put into orbit to monitor and report on atomic blasts in outer space. Three possible systems were proposed by the Geneva experts. One calls for five or six satellites orbiting at altitudes of more than 18,000 miles. These would be equipped with the necessary instrumentation and would be so distributed as to allow for complete surveillance of the earth. Because of the cost of this system, the scientists offered two alternate systems. One would employ six to ten satellites orbiting at an altitude of about 350 miles. This, according to the experts' report, would allow for complete surveillance with the exception of limited and predictable areas. The third system would employ a smaller number of satellites at about the same altitude as those of the second system, and there would be similar blind areas.

Western sources emphasized that the proposed detection system was com-

pletely feasible in terms of present technology. No new inventions will be needed, but much hard engineering work will have to be done, it was stated.

The United States' scientists were led by Wolfgang K. H. Panofsky, head of the high-energy physics laboratory at Stanford University. The leader of the Soviet group was Yevgeny K. Fedorov of the Soviet Academy of Sciences. Henry Hulme, adviser to the Defense Ministry, was the British leader.

Western observers hailed the completion of the report in less than 3 weeks as a major achievement.

Non-nuclear Club Proposal Studied in England

A plan for the formation of a "non-nuclear club" of major nations other than the United States and Russia is currently being debated in England. The proposal, that the possession of nuclear weapons be limited to these two countries through voluntary action on the part of club members, has been advanced, in slightly different forms, by the Labor Party and by the editors of the influential Manchester Guardian. *According to English commentators, the Labor Party's attitude toward the plan was originally passive. In recent weeks, however, its attitude has changed to one of active advocacy, with leading members of the party, such as Gaitskell and Bevan, taking part in the campaign. One version of the non-nuclear club proposal was discussed in the 25 June issue of the* Guardian; *the following questions and answers are taken from that discussion.*

What Is Proposed?

The British are to try to stop the spreading of nuclear weapons to fourth, fifth, and sixth nations and so to the nth nation. Our Government should seek an agreement through the United Nations that nobody except the Americans and Russians will make or acquire any nuclear weapons. If such agreement is reached the British must be ready to destroy or hand over their separate weapons.

Why Leave Out the Americans and Russians?

Because an agreement which lets them keep their weapons will be easier to negotiate. Each of them—quite rightly—regards its bombs and missiles as vital to its security against the other. Neither will give them up for a long time to come. But other nations apart from the British do not possess nuclear weapons. Therefore they are being asked only to deny themselves something that they have so far done without.

The United States and Russia must, however, support the agreement. They must undertake not to supply weapons to anyone else.

What about Control?

Control is possible in two ways. The first is to check the use of all fissile materials produced by reactors, which is said to be technically practicable. The second is to find out whether countries are equipping themselves with medium or long-range missiles. Such missiles are one of the principal means of delivering nuclear weapons, and they are too expensive to be worth producing except for use with nuclear warheads. This form of control leaves two loopholes—the chance that the Americans and Russians may secretly supply someone else, contrary to the agreement, and the chance that aircraft rather than missiles may still be used to carry nuclear bombs. There can be no thorough protection against these possibilities. (Nor, of course, is there thorough protection in any other practicable policy.)

What Is Gained?

Chiefly a reduction in the risk of nuclear war. If the spreading of weapons is not stopped, sooner or later someone will use them. Once anyone uses them a world war is likely (though not certain) to come by a chain reaction. This is because of the premium which to-day's nuclear weapons place on instant action. You must hit back at once or your means of retaliation may be destroyed. Bombers on airfields and missiles on fixed land bases are vulnerable; and if country X (large or small) has reason to suppose that its potential enemy Y is preparing an attack or has launched one, it must get its bombers or missiles into the air at once. (Bombers can be recalled: missiles cannot.) Nuclear weapons to be effective as a deterrent must be constantly ready for firing. Consequently X and Y, even if politically not in a crisis of conflict, militarily must remain tensely alert against each other.

At present, when only three nations manufacture nuclear weapons, it may be possible to prevent their spreading. Once a number of nations have them, international control will be beyond attainment. When a bomb or warhead has been made or stored it can be discovered only by a screwdriver. Further, as a former chief of staff of the I.R.A. (now the Irish Foreign Minister) has said, the weapons of armies to-day become the weapons of revolutionary movements to-morrow.

Small nations, with less to lose than large industrialized nations, may be more ready to risk using their nuclear weapons. And, the more widely these weapons are distributed, the greater the risk that they will come under the control of unstable governments or impetuous officers.

Can It Help towards Comprehensive Disarmament?

Yes. You have to have a starting point, which may be with ending tests, or with a form of disengagement in Europe, or with stopping the spread of nuclear weapons—or with all three. The Americans and Russians are unlikely at present to allow thorough inspection of their factories or bases, so there is value in a control system which can be demonstrated in practice first on the territory of other nations. To say that it should not be accepted until there is general agreement on comprehensive disarmament is like saying that the United Nations should not have been accepted because it was less than an effective world government. The non-nuclear club can be one of the stages on the road to greater disarmament.

What about the French?

The French Government is now so fully committed to making its own bombs that it cannot stop or be stopped. It can, however, be asked to join the British after it has proved its bomb-making ability. It can be asked to sponsor the non-nuclear club jointly with the British. Will it do so? Not if President de Gaulle is immovably convinced that Western Europe must build a deterrent force of its own, so that it can stand apart from the Americans. But if he is chiefly concerned with securing equality of status with the British, his point can be met.

And the Chinese?

The Chinese may be brought into the non-nuclear club as part of an agreement to admit them to the United Nations. Alternatively, if they insist on parity with the Americans and Russians

the proposal may have to be revised. It may then be necessary to suggest that the British and French—or the British, French, and West Germans jointly—continue to hold their weapons. In effect two nuclear powers on each side would then exist. An attempt would have to be made to get the non-nuclear club sponsored by nations such as Japan, India, and Sweden. But obviously the greater the number of nations who insist on having their own weapons the less the hope of ever forming a non-nuclear club.

What about NATO?

The British proposal will have to be agreed beforehand with our allies in NATO. It ought to be as much in their interests as it is in ours. The dangers which flow from a multiplication of nuclear nations are common to all.

The difficulties here will lie in General Norstad's insistence on the need for tactical atomic weapons in Europe. This can be overcome in either of two ways. One is to let the Americans hold these weapons on behalf of the alliance (as substantially they do at present). The other is to recognize that tactical weapons cannot be used in Europe without so great a risk of all-out war that they are not worth having.

And American Bases?

These can remain in Britain. The non-nuclear club need not prevent their presence here. On the contrary, since the American strategic deterrent remains (as to-day) the key element in Western defence, the Americans ought to be given what facilities they want in the British Isles. So long as we shelter under the American's umbrella—as we have done ever since 1945—we must be ready to help hold it aloft.

When the Americans have produced enough reliable long-range missiles their need for overseas bases will decline. We have to recognize that they will then be less ready to risk an all-out war in defence of Western Europe. Their military guarantee of Western Europe may then become less reliable. This is one disadvantage of the non-nuclear club. Western Europe will be more vulnerable to Soviet threats. But at the same time if the Americans return to their earlier monopoly of nuclear weapons in the West their obligation to Europe is increased.

How Many Must Agree?

Before the club can be formed those countries which might have nuclear weapons in the next decade or so must come in. They include France, China, Japan, Sweden, Switzerland, Western Germany, Eastern Germany, India, Pakistan, Israel, the United Arab Republic, Argentina, Brazil, Poland, Czechoslovakia, Hungary, Bulgaria, Greece, Turkey, Canada, Australia, South Africa, and possibly some others. It is doubtful whether the club could be of any value if one of these countries stood out against it. But again they share a common interest in trying to prevent the spread of nuclear weapons.

The Americans and Russians must underwrite the agreement. If they were to agree also to inspection of their use of fissile materials—to begin, say, two years after the club had been formed—that would be most helpful.

Is It Likely To Succeed?

That depends in part on whether any British Government is willing to pursue the proposal with vigor. The British at present are particularly well placed to take the initiative. At later dates others may be better placed.

What if Other Countries Refuse?

Any British Government is bound to leave itself freedom of action in that event. It may choose to retain its separate weapons—although it may think that the development of new weapons is economically not worth while—or it may not retain them. Most probably it will be best to keep what it has in an increasingly uncomfortable world.

Space Agency-Pentagon Liaison Group Given New Authority

The Civilian-Military Liaison Committee, a governmental group composed of representatives of the National Aeronautics and Space Administration and the Defense Department, has been given expanded authority by President Eisenhower to deal with jurisdictional differences that arise between the two agencies. Both NASA and the Department of Defense are concerned with space projects. In the past, when conflicts arose between them, either had the option of asking the liaison committee to mediate. Under the new charter which President Eisenhower has recently approved, such conflicts must be mediated by the committee whether or not either of the participants requests such action. In a related development, William M. Holaday, chairman of the committee, was released from other duties, including that of director of guided missiles, to spend full time on liaison problems.

The action reflects a continuing effort by the Administration, under the prodding of Congress, to establish order and lines of authority among the many federal agencies concerned with space activities. Last February, similar action was taken when Herbert York, director of defense research and engineering, was given explicit authority to approve, modify, or disapprove programs and projects of all Department of Defense agencies, including the military services.

Cut in Space Budget

In another development involving the space agency, the House of Representatives cut $68 million from NASA's proposed budget of $530 million. This reduction, agency officials warned, will have the effect of slowing down United States efforts to place a man in space. The funds are needed, a spokesman said, for research and for the procurement of space capsules for Project Mercury, NASA's manned-satellite program.

Behind the cut are arguments put forth by Representative Albert Thomas (D-Tex.), a member of the House of Representatives' Appropriation Committee. Thomas has commented that the space agency has "more money than they can spend wisely." He also suggested that NASA should not be rushed in its activities.

After the House action was taken, T. Keith Glennan, administrator of NASA, issued a statement saying that the recommendations of the committee imperiled American leadership in space research. "We cannot win this race," he said, "without all-out support from Congress." Congress itself had set the goal of leadership in space, he continued, by enacting the legislation that created NASA. According to an agency spokesman, the cuts would have a critical effect on the research and development programs which form the core of NASA's activities. In addition to slowing the man-in-space program, the spokesman said, the cuts would force curtailment of new tracking-range plans, slow down the schedule of satellite and space-probe shots, and delay development of more powerful boosters and vehicles of advanced design.

Agency officials are hoping for a restoration of the cuts by the Senate, which also has to pass on NASA's request for funds. Even full restoration by the Senate, however, would probably not wholly offset the action of the House,

because the House and Senate appropriations will have to be reconciled by compromise. It is unlikely that the House will reverse itself and finally allow the full amount in this compromise. Most usually the final appropriation figure falls between the upper and lower limits set by each chamber.

Atomic Clock To Orbit

A 30-pound atomic clock to be carried in an orbiting satellite is being developed, to give Einstein's general theory of relativity "the most searching check of its 43 years." The prototype of the clock is now under construction at the Hughes Aircraft Company's research laboratories at Culver City, Calif., under a $200,000 development contract from the National Aeronautics and Space Administration. The clock will be accurate to within 3 seconds in 100 billion; this means an error of no more than 3 seconds in 3171 years. NASA has given similar contracts to the National Bureau of Standards and to Massachusetts Institute of Technology for other types of very precise clocks. Any actual satellite-clock launching is probably several years away, NASA said.

Before the launching, the atomic clock would be synchronized with another clock on the ground. The satellite would then orbit, at an altitude, for example, of 8000 miles, traveling about 18,000 miles an hour. The orbiting clock would generate a highly stable current with a frequency of 24,000 megacycles per second. By means of electronic circuits the rate of these oscillations would be reduced to a rate at which precise laboratory measurements could be conveniently made. The "ticks" would be transmitted by radio for comparison with data from the clock on the ground.

Harold Lyons, inventor of the first atomic clock, examines the tubular core of another model which is to be put into orbit around the earth to check Einstein's general theory of relativity.

Administration Reaffirms Stand on Nuclear Plane

The Administration has rejected proposals for early construction of a flying model of a nuclear-powered aircraft. The proposals, which had been examined in the past, were brought up for review at the insistence of members of the Joint Congressional Committee on Atomic Energy, who cited the propaganda advantages of building such a plane before the Soviet Union does. In rejecting the "fly early" proposals the Administration indicated that efforts would be concentrated on development of more advanced reactor fuel elements for the reactor-jet-engine combination that will eventually power the craft.

The decision reflects the Adminstration's belief that more research is needed before an adequately performing power plant can be developed for the plane. This point has recently been stressed by White House science advisers and Pentagon officials. In his last speech before leaving office, James Killian, chairman of the President's Science Advisory Committee, spoke of the need for careful preliminary work before continuing the nuclear plane project. Herbert York, research chief of the Department of Defense, said in testimony before a House committee that he believed the over-all cost of developing such a plane would be at least $10 billion. It has been estimated that approximately $1 billion has been spent on the project over the past 13 years.

Members of the Joint Congressional Committee on Atomic Energy described the Administration's move as a "backward step" that will postpone the first flight of a nuclear airplane by at least 2 years. Representative Melvin Price (D-Ill.), chairman of the Atomic Energy Research subcommittee, announced that public hearings would be held next month on the Administration's "lack of decision" on the controversial project.

Scientists in the News

WARREN WEAVER, vice president for the natural and medical sciences of the Rockefeller Foundation, will retire on 1 August. At that time he will become vice president of the Alfred P. Sloan Foundation. He will continue his activities on the National Science Board, on the National Advisory Cancer Council, on the Council for Library Resources, as vice chairman of the Health Research Council of the City of New

York, and as vice president and chairman of the committee on scientific policy of the Sloan-Kettering Institute for Cancer Research. After 1 July he will make his home in New Milford, Conn.

KENNETH STREET, deputy director of the University of California's Lawrence Radiation Laboratory, Livermore, has been appointed professor of chemistry on the Berkeley campus.

CHARLES G. OVERBERGER, head of the chemistry department at the Polytechnic Institute of Brooklyn, has been elected chairman of the New York section of the American Chemical Society.

CLARENCE ZENER, director of the Westinghouse Research Laboratories, Pittsburgh, Pa., will receive the John Price Wetherill Medal from the Franklin Institute on 21 October.

VERNON CHEADLE, chairman of the department of botany at the University of California, Davis, recently left for Australia, where he will spend 9 months on sabbatical leave with the Division of Forest Products, Commonwealth Scientific and Industrial Research Organization, Melbourne.

PETER H. NASH, associate professor of city and regional planning and research associate in the Institute for Research in Social Science at the University of North Carolina, has been appointed head of the University of Cincinnati's new department of geography, effective 1 September. The university's department of geology and geography will be broken down into two separate departments at that time.

JOHN H. HAMMOND, JR., president of the Hammond Research Corporation and a director of the Radio Corporation of America, will be awarded the Elliott Cresson Medal by the Franklin Institute, Philadelphia, Pa., on 21 October.

MORRIS SCHAEFFER, director of the Virus and Rickettsia Laboratories of the U.S. Public Health Service's Communicable Disease Center, has been appointed director of the Bureau of Laboratories for the City of New York Department of Health. He will also serve as a member of the Public Health Research Institute in New York City and as professor of medicine, New York University–Bellevue Medical Center.

GEORGE L. HAGEN, Jane Coffin Childs fellow in the department of botany at Harvard University, has been appointed research associate of the Institute for Cancer Research, Philadelphia, Pa. JOHN G. TORREY, associate professor of botany at the University of California, Berkeley, will be a visiting associate member of the institute for 6 months, beginning in July. JAKOB REINERT, lecturer at the Botanisches Institut der Universität, Tübingen, Germany, will also spend 6 months at the Institute for Cancer Research, beginning in September or October.

ELIAS J. COREY, professor of chemistry at the University of Illinois, has been appointed professor of chemistry at Harvard University.

HARRY SOBOTKA, chemist-in-chief at Mount Sinai Hospital, New York, will lecture during August in Brazil, at the Instituto Oswaldo Cruz in Rio de Janeiro and at other institutions in Brazil, Uruguay, and Chile.

EMERSON W. CONLON has taken leave of absence as director of research at Drexel Institute of Technology to accept appointment as assistant director of aeronautical and space research with the National Aeronautics and Space Administration, as of 6 July. He succeeds ADDISON ROTHROCK, who is now scientist for propulsion in the National Aeronautics and Space Administration's Office of Program Planning and Evaluation.

Brigadier General JOHN K. CULLEN, director of plans and hospitalization, Office of the Surgeon General, U.S. Air Force, has been appointed deputy surgeon general of the Air Force, effective 1 August. He succeeds Major General OLIN F. McILNAY, who will retire.

HENRY A. BOORSE, chairman of the Barnard College physics department, has been appointed dean of the faculty at Barnard. He succeeds THOMAS P. PEARDON, who is resuming full-time teaching in the department of government in addition to taking on new duties as editor-in-chief of the *Political Science Quarterly*.

HENRY W. HICOCK, head of the department of forestry at the Connecticut Agricultural Experiment Station, New Haven, since 1946, will retire after 42 years' affiliation with the station.

Recent Deaths

JACOB E. FINESINGER, Baltimore, Md.; 57; head of the Psychiatric Institute and founder and head of the psychiatric department at the University of Maryland; had taught at Harvard University and studied in the Soviet Union under Pavlov; 19 June.

Sir IAN C. ROSS, Melbourne, Australia; 60; chairman of the Commonwealth Scientific and Industrial Research Organization since 1949; formerly professor of veterinary science at Sydney University; director of scientific personnel with the Commonwealth Directorate of Manpower and adviser on pastoral industry to the Department of War Organization of Industry, 1942–45; 20 June.

GRACE M. SICKLES, Troy, N.Y.; 61; associate research scientist in the Division of Laboratories and Research of the New York State Department of Health and a member of the department since 1918; codiscoverer of the Coxsackie virus, identified during a study of outbreaks of poliomyelitis in New York State; performed extensive research on various antibacterial serums; 29 June.

ALBERT N. STEWARD, Corvallis, Ore.; 62; professor of botany and curator of the herbarium at Oregon State College, since 1951; previously head of the botany department at the University of Nanking, China, for 30 years; 19 June.

ABRAHAM STONE, New York; 68; urologist; associate clinical professor of preventive medicine at the New York University–Bellevue College of Medicine, and a faculty member of the New School for Social Research; director of the Margaret Sanger Research Center since 1941; founder and president of the American Association of Marriage Counselors and vice president of the Planned Parenthood Federation; special consultant on family planning to the World Health Organization; coauthor of *Planned Parenthood*; 3 July.

JOHN G. TAPPERT, Philadelphia, Pa.; 53; physicist with the U.S. Army Ordnance's Frankford Arsenal, Philadelphia, Pa., where he had been employed since 1935; inventor of instruments for the control of artillery fire, including automatic computers for antiaircraft guns; 12 June.

PHILIP J. ZLATCHIN, New York; 46; professor of psychology at New York University's Graduate School of Arts and Science and professor of education at the university's School of Education; 3 July.

Book Reviews

The Ineffective Soldier. vol. 1, *The Lost Divisions.* Eli Ginzberg, James K. Anderson, Sol W. Ginsburg, and John L. Herma. xx + 225 pp. vol. 2, *Breakdown and Recovery.* Eli Ginzberg, John B. Miner, James K. Anderson, Sol W. Ginsburg, and John L. Herma. xvii + 284 pp. vol. 3, *Patterns of Performance.* Eli Ginzberg, James K. Anderson, Sol W. Ginsburg, John L. Herma, Douglas W. Bray, William Jordan, and Francis J. Ryan. xix + 340 pp. Columbia University Press, New York, 1959. $6 per volume.

These three volumes present the results of a major investigation by the Conservation of Human Resources Project of Columbia University, begun in 1950 and carried out under the direction of Eli Ginzberg. The authors attempt to tell "what really happened during World War II in the screening and utilization of the several million men who had mental and emotional handicaps" and to find a relationship between the loss of millions of men to the services, either through the original screening procedure or through subsequent separation because of some failure in performance during service, and the manpower policies responsible for the situation. It is the expressed hope of the authors that such an assessment will prepare the ground for more sensible selection and utilization policies in the future. A secondary goal is the derivation of guide-lines which will be of assistance to industrial management in meeting the civilian problems of selection, utilization, and, presumably, separation of employees in American industry.

Use is made of the rough over-all figures on selection and rejection of recruits, as provided by the induction centers, and on over-all enrollment and subsequent separation, as provided by the military services. These mass data are supplemented by a more intensive (though admittedly still superficial) study of 3854 Army recruits enrolled during the last four months of 1942 and subsequently separated from the Army because of poor performance. This sample represents approximately 5 percent of the 72,700 men subsequently discharged for reasons of performance from among the 1,764,900 men enrolled during this period. A more intensive study, utilizing data from the Veterans Administration and from a questionnaire sent to many of the men, is made of a smaller sample of 534 cases. Some of the authors' sweeping pronouncements concerning the military manpower situation during World War II, therefore, derive from a distinctly limited number of cases representing a relatively short period of time.

The three volumes are published as an integrated series, but each is written in such a way that it may be read separately with profit. As a result there is considerable overlap, and one gets the impression that a single, concisely edited, large volume would have been both adequate and more modest. Publication of three separate volumes seems somewhat pretentious. In listing the volumes in the order of their importance and contribution to the authors' goals, I would place the last volume first, the first volume second, and the second volume a poor third.

Volume 1, *The Lost Divisions,* gives a sympathetic account of the difficulties involved in the sudden creation of a mass army and the near chaos that resulted from manpower policies that were often unrealistic, always vacillating, and never fully explained to the men delegated to execute them. The description is accurate, the comment penetrating, but the conclusions, while sound, bear no tight logical relation to the statistics used to buttress them. The authors are talking wisely and to the point, but one feels that they are speaking from a broad background of personal experience rather than with authority based on their experimental findings. The impression constantly recurs, throughout the study, that the data were collected on a *post hoc* basis to justify an a priori set of logical conclusions. As a result, the authors emerge as better publicists and humanitarians than scientists.

The volume also contains an analysis of the relation to performance of such background factors as age, marital status, educational level, and race. Nothing is added here to the classical picture already presented in many earlier studies by previous investigators. There is a basic conflict, damaging to the argument but apparently not disturbing to the authors, between the firmness of the conclusions and the frequent inadequacy of the data upon which the conclusions are based. If the examinations conducted at the induction centers were as crude and as productive of errors as the authors claim, it is difficult to see how any confidence can be placed in statistics derived from the examinations. Again, if Army manpower policies were as stupidly conceived and as carelessly executed as is implied here, what validity can we attribute to the data resulting from these procedures?

Volume 2, *Breakdown and Recovery,* consists of a collection of brief case histories selected to illustrate the various types of performance in such problem areas as personality, family pressure, military organization, cultural conflict, and situational stress. The histories average from 800 to 1000 words each and, admittedly, "cannot be used for an exhaustive clinical analysis." They are accompanied by simple summaries, in the nature of pleasant little homilies, which often overstate the facts and certainly are to be considered educational and missionary endeavors rather than scientific interpretations. Here again one feels that the authors are writing as publicists in a good cause rather than as investigators objectively analyzing research data.

Volume 3, *Patterns of Performance,* the most comprehensive and interesting of the three volumes, integrates the mass statistical data and the clinical materials and brings in some new and interesting approaches to readjustment by interpreting the follow-up data obtained through the Veterans Administration. This section is fresh and novel, but once more the interpretations range beyond the limits set by the somewhat superficial and inadequate data. Certainly the Veterans Administration procedures will neither stand nor fall on the basis of the statistical findings presented here.

There is also a chapter on the management of men, designed to spell out

the lessons applicable to civilian industry, but it bears no close relation to the data that precede it. Again one senses the touch of the publicist rather than the scientist.

The prose style is lively and interesting, and the books are pleasant to handle and easy to read. The busy executive who wishes an introduction to the problems of military manpower will find it here. The serious researcher in the field, however, will be disappointed. The story has all been told elsewhere, usually with more data and more sophisticated experimental designs. Without wishing to detract from the valuable work of the Conservation of Human Resources Project, I note with pleasure that current military research in the manpower field is well ahead of the civilian effort represented here.

WILLIAM A. HUNT
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Northwestern University

Hunger and Food. Special edition of *Science and Mankind.* Josué de Castro, Ed. World Federation of Scientific Workers, London, 1959. 123 pp. 10s.

A few years ago UNESCO sponsored a series of publications entitled *Food and People.* These six booklets, ranging in size from 24 to 64 pages, dealt with the problem of food supply and population and were written in a remarkably lucid, comprehensive, scientific, and forthright manner. The subjects covered are indicated by the titles: *Food and the Family,* by Margaret Mead; *UN Sets the Table,* by Peter Kihss; *Food and Social Progress,* by André Mayer; *Distribution of the World's Food,* by Stefan Krolikowski; *Are There Too Many People?,* by Alva Myrdal and Paul Vincent; and *Food, Soil, and People,* by Charles E. Kellogg. The authors tried to set the stage for thoughtful discussions, and they avoided pompous and partisan statements on insufficiently documented points. The keynote of the series was perhaps exemplified in this quotation by André Mayer: "The population problem is not a simple problem to be resolved . . . by a mere change in the agriculture technique. It is also an economic problem, an educational problem, and a social problem. It is a problem involving the whole organization of society."

An organization called the World Federation of Scientific Workers has just published, under the editorship of Josué de Castro, a book entitled *Hunger and Food,* which is almost a parody of the UNESCO series on the same subject. The introductory chapter, by de Castro, is full of such vague notions as "biological possibilism," "antagonisms of nutrition principles," and "advance agents preparing the ground for tuberculosis, tracoma, leprosy, verminoses, and other gastrointestinal parasitoses." The keynote of the introduction is that the symposium will be "useful to all those who wish in some way to participate in this universal crusade which is inescapable in view of the circumstances presented—that is, in the universal crusade of struggle against hunger."

The second chapter, by Lord Boyd Orr, delivers an utterly confused political diatribe. In the first part Orr dispenses such pearls of wisdom as "they [the peoples of the European nations] were not prepared to die to make the world safe for either Communism or Capitalism," and he proclaims that freedom from war could be secured if a world police force were created to enforce the decision of an effective court of justice. No thought is given to the fact that, were the world ready to create such instruments, there would be very little reason to fear a world war anyway. After some generalities on technology and medicine, Orr poses the question: "What number of people can the earth support?" Most of the data he quotes—on the Bengal famine, the nutritional situation of the United States in the 1930's, the postwar recovery, and so forth—have little relevance to the world as it is today. However, they can be used to support both of the attitudes which Orr has struck in past years and which he attempts to reconcile here: that of a nutritional banshee claiming that the world is on the verge of starvation, and that of a prophet of abundance proclaiming that "the world is rich" and that, by following a few simple organizational rules, everything will be straightened out in short order.

The next chapter, by the late T. Roemer of Halle, Germany, is a surprisingly reasonable dissertation on Malthus, in which Roemer takes issue with Boyd Orr and points out that so far none of the dire predictions of Malthus have been confirmed and that they are not likely to be confirmed immediately, although it is difficult to foresee what may happen after the year 2000.

The rest of the book continues to be uneven, with some acceptable chapters, in particular that by Michel Cepede of France and that by Cicely Williams of Great Britain. As an example of unacceptable "scientific" statements, one in the chapter on "Soil and man," by F. E. Bear of Rutgers, can be cited: "the Shetland pony turns into a horse when taken to a region where the forage is high in minerals and protein." As an example of questionable political "fact," the conclusion of R. Dumont of Paris will serve, among others: "Economy based on profits is becoming weaker and having difficulty in adapting itself to a situation of relative abundance (relative, that is to say, to an inadequate purchasing power), is tending towards a futile malthusianism, towards a reduction to destitutism. This will shortly lead to its general condemnation, if we persist in exposing its defects."

The papers by scientists from the other side of the Iron Curtain are mediocre. Masek, of Prague, asserts that the protective influence of vitamin C with respect to atherosclerosis has been demonstrated. Yang En-Fu, president of the Agricultural Association of China, emphasizes the "astonishing labor enthusiasm of peasants in the cooperatives," a statement which is not in accordance with the comments of less biased observers.

The book ends with a chapter by Kursanov and Nichiporovich of the Timiryazev Institute of Plant Physiology, Academy of Sciences, Moscow, who believe that the problem of food supply will be solved by "raising the photosynthetic productivity of plants."

In summary, this book is in the main more a vague political manifesto than a scientific document; it is not likely to shed much light on the important problem of food and population.

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Translators and Translations. Services and sources. Francis E. Kaiser, Ed. Special Libraries Association, New York, 1959. iv + 60 pp. $2.50.

This very timely and useful guide represents a further effort on the part of the Special Libraries Association to assist librarians, literature scientists, and particularly the scientific community as a whole by bringing together information on widespread translation activities.

Part 1, "Directory of translators," lists services, rates, languages, subject specialties, addresses, telephone numbers,

and other pertinent facts about 154 translators in the United States.

Part 2, "Pools of translations," lists services, size, scope, languages, subject fields, and index publications for 42 translation pools throughout the world.

Part 3, "Bibliographies of translations," cites 83 published bibliographies of translations and includes an informative abstract for each entry.

A geographical-subject-language index with cross references is included, together with two appendixes: "Other services offered by translators" (that is, abstracting, photocopying, editing, searching, and so forth) and "Publishers of bibliographies" (which gives the mailing addresses of the publishers of bibliographies listed in part 3).

The value of this guide would be enhanced by inclusion of qualitative evaluations of the translations produced by individual translators or organizations—perhaps in the form of ratings similar to the movie evaluations that appear in *Consumer Reports*.

CHARLES M. GOTTSCHALK
Science and Technology Division, Library of Congress

Radiographic Atlas of Skeletal Development of the Hand and Wrist. William Walter Greulich and S. Idell Pyle. Stanford University Press, Stanford, Calif.; Oxford University Press, London, ed. 2, 1959. xvi + 256 pp. Illus. $15.

The Greulich-Pyle *Atlas*, now in its second edition, has become a classic in its field. Regarded as indispensable to pediatricians and radiologists, the *Atlas* is also an important reference volume for general practitioners, experimental investigators, and students of skeletal development, generally.

The quality of reproduction of the plates in this edition surpasses even that of the handsome first edition. Several new standards have been introduced, so that in the current edition no unduly long intervals occur in the presentation of the developmental sequence. Revision of the section entitled "Maturity indicators" has been accomplished with the utmost clarity. In the developmental line graphs (skeletal versus chronologic age), the range of standard deviation, based on the normal population studied, may be appreciated more readily than as presented in the first edition. Convenient scales are included on both the vertical and horizontal coordinates of the developmental line graphs. The valuable tables for predicting adult height from skeletal age, by Bayley and Pinneau, which had been revised for use with the Greulich-Pyle hand standards, have been included in the second edition.

The *Atlas* stands as a proud memorial to the much beloved, highly esteemed professor T. Wingate Todd.

D. G. WALKER
Department of Anatomy, Johns Hopkins University School of Medicine

College Testing. A guide to practices and programs. Prepared by the Committee on Measurement and Evaluation of the American Council on Education. The Council, Washington, D.C., 1959. 189 pp. $3.

College Testing, prepared by the Committee on Measurement and Evaluation of the American Council on Education, is intended for study and use by college teachers and administrators. Part 1 deals with the role and administration of measurement programs in college and discusses the use of tests in the admission of students, the placement of students in courses, educational counseling, the evaluation of student performance in courses, and general institutional evaluation. Part 2 describes the testing programs found at seven representative colleges and universities: Chatham College, the College of the University of Chicago, Dartmouth College, College of Arts and Sciences of the University of Louisville, the Counseling Bureau of the University of Minnesota, Pasadena City College, and San Francisco State College.

The aim of the Committee on Measurement and Evaluation was to write a statement on college testing which would be understandable and useful to the college teacher and administrator not trained in educational and psychological measurement. The authors hold the view that many tests and evaluation instruments are receiving less attention than they deserve, because many college teachers and administrators are unaware of their existence, their applicability, or their range of utility. *College Testing* is designed to give a minimum of background information about testing and a description of ways in which some institutions are using tests and, perhaps most important, to provide a stimulus to seek further information about testing. The committee is to be commended on its success in achieving this goal.

It is difficult to write a statement of the kind which is attempted in *College Testing*. The reader who knows a good deal about testing may be inclined to say that he is already well versed in what is said about tests in this publication; the person with no background in testing may feel that he isn't quite well enough prepared to read the statement with full comprehension. I believe that the statement will be of maximum usefulness in a faculty seminar on testing, led by a specialist in this field.

It seems to me that the usefulness of the book would have been enhanced by the inclusion in part 1 of more illustrative data. Such data are included only in connection with the analysis of test scores. The use of similar illustrative data in the discussion of other topics would have helped to clarify certain concepts and the application of test results to specific situations. The usefulness of tests in educational research could also have been given more emphasis.

In the years immediately ahead, with the ever-increasing enrollments that are predicted, more and more tests will be used on the college campus. *College Testing* should provide a helpful starting point for faculty members, administrators, and test specialists to begin discussions of testing problems on a particular campus.

DEWEY B. STUIT
State University of Iowa

One Great Society. Humane learning in the United States. Howard Mumford Jones. Harcourt, Brace, New York, 1959. xiii + 241 pp. $4.50.

This is an important book, written by just the right man, about a subject of fundamental national concern, and at a critical moment in the development of our country. Dealing authoritatively with our cultural heritage, the present state of our national values, and, by implication, with our readiness to play a mature role in helping to fashion tomorrow's world, this work deserves the attention of all thoughtful Americans.

This book, by a dean of American humanists, constitutes a brilliant course on the humanities. With his usual deftness Howard Mumford Jones disperses, by the use of clear definition and apt illustration, the vagueness which often surrounds terms such as *culture* and *humanities*. Good humanist that he is, he elucidates such values as respect for information coupled with skill in using it;

the ability of the individual "living in the secret chamber of himself" to use "experience of beauty and faith to get [himself] through"; and collective confidence in presenting to the rest of the world "a coherent, sensible, and persuasive philosophy of democracy."

The author's main purpose, however, is to alert us to a dangerous imbalance in our national culture. For example, in 1951, the per capita expenditure for original research in science was estimated to be $1800; in the social sciences, $600; and in the humanities, $130. The endowment of the American Council of Learned Societies is $65,000, that of the Social Science Research Council, about $3 million, while the National Research Council "does not have to worry about endowment since it is supported by the United States Government."

In urging a better balance, Jones values the natural and social sciences too highly to suggest that they be deemphasized, but he points out that support for the humanities does need to be brought into line. He proposes modestly that "we ought immediately to increase our support . . . by at least fifty million dollars a year—and then go on from there" and itemizes twenty specific needs which the humanities can be expected to meet. That we will not as a nation make the necessary effort, once we really understand the issues involved, is unthinkable. We must look to the humanists for vigorous leadership—the kind of leadership of which this book is an admirable example.

THEODORE ANDERSSON
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Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

The Atlantic Cable. Bern Dibner. Burndy Library, Norwalk, Conn., 1959. 95 pp. Cloth, $3.50; paper, $2.50.

Australia, Commonwealth Scientific and Industrial Research Organization, Tenth Annual Report, 1957–58. Parliament of the Commonwealth of Australia, Canberra, 1959. 174 pp. 14s.

Axenic Culture of Invertebrate Metazoa: A Goal. Annals of the New York Academy of Sciences, vol. 77, art. 2, pp. 25–406. Ellsworth C. Dougherty, Consulting Ed. The Academy, New York, 1959. $4.50. This series of papers is the result of a conference held and supported by the Academy and by the Kaiser Foundation of Oakland, Calif. The papers are divided as follows: part 1, "The lower Metazoa: free-living forms (except nematodes)"; part 2, "The lower Metazoa: parasitic worms and free-living nematodes"; part 3, "The Mollusca"; part 4, "The Arthropoda: Crustacea and Chelicerata"; part 5, "The Arthropoda: Insecta."

Better Utilization of College Teaching Resources. A summary report. Committee on Utilization of College Teaching Resources. Fund for the Advancement of Education, New York, 1959. 62 pp.

The Biographical Approach to John Dalton. Manchester Literary and Philosophical Society, memoirs and proceedings, vol. 100. Frank Greenaway. The Society, Manchester, England,1959. 98 pp. £1 1s.

The Chemical Industry Facts Book. Manufacturing Chemists' Association, Inc., 1625 Eye St., NW, Washington, ed. 3, 1959. 149 pp. $1.25.

Commemoration of the Centennial of the Publication of "The Origin of Species" by Charles Darwin. Proceedings of the American Philosophical Society, Philadelphia, vol. 103, No. 2, pp. 159–319. 23 Apr. 1959. $1. Contents: "The crucial evidence for human evolution" (W. E. LeGros Clark); "The concept of natural selection: a centennial view" (I. M. Lerner); "Variation and heredity transmission" (C. Stern); "Darwin's views on variation under domestication in the light of present-day knowledge" (A. Müntzing); "Isolation as an evolutionary factor" (E. Mayr); "The role of hybridization in evolution" (G. L. Stebbins); "Variation and evolution" (T. Dobzhansky); "The nature of the fossil record" (N. D. Newell); "Anatomy and morphology: Classification and evolution, 1859 and 1959" (G. G. Simpson); "Darwin and zoogeography" (P. J. Darlington, Jr.).

Current Research and Development in Scientific Documentation. No. 4. Office of Science Information Service, National Science Foundation, Washington (order from Supt. of Documents, GPO, Washington 25). 85 pp. $0.15.

Engineering Societies Directory, 1959. International and national joint bodies; national, state, regional, and local societies; registration; Canadian societies. Engineers Joint Council, 29 W. 39th St., New York, 1959. 36 pp. A revision of the 1956 edition.

An Evaluation of the First Academic-Year Institute, University of Utah, 1957–58. Frank B. Jex and Reed M. Merrill. University of Utah, Salt Lake City, 1959. 65 pp.

Geophysical Activity in 1958. Committee on Geophysical Activity, Society of Exploration Geophysicists, Tulsa, Okla., 1959. 36 pp.

Germfree Vertebrates: Present Status. Annals of the New York Academy of Sciences, vol. 78, art. 1, pp. 1–400. James A. Reyniers, Consulting Ed. The Academy, New York, 1959. $5. This series of papers is a result of the conference sponsored by the Academy and the Runyon Memorial Fund for Cancer Research. The papers are divided as follows: part 1, "Instrumentation for rearing germfree vertebrates"; part 2, "Rearing germfree vertebrates"; part 3, "Characteristics of germfree and disease-free animals"; part 4, "Use of germfree vertebrates in research"; part 5, "Present status and future development of germfree life studies."

Guides for Developing Curricula for the Education of Practical Nurses. Dorothea E. Orem. Office of Education, Washington, 1959 (order from Supt. of Documents, GPO, Washington 25). 165 pp. $0.60.

Haffkine Institute Diamond Jubilee, 1899–1959, Souvenir. Haffkine Institute Celebrations Committee, Bombay, India, 1959. 140 pp.

Hypertension and Coronary Heart Disease: Classification and Criteria for Epidemiological Studies. WHO Technical Report 168. First report of the Expert Committee on Cardiovascular Diseases and Hypertension. World Health Organization, Geneva, Switzerland, 1959. 28 pp. $0.30.

Introduction to the Physical Sciences. Morris Goran. Free Press, Glencoe, Ill., 1959. 421 pp. $6.

Machine Design Problems. Donald J. Myatt. McGraw-Hill, New York, 1959. 186 pp. $5.50.

Mammals of the San Francisco Bay Region. William D. and Elizabeth Berry. 72 pp. *The Natural History of the San Francisco Bay Region.* Arthur C. Smith. 72 pp. *Native Trees of the San Francisco Bay Region.* Woodbridge Metcalf. 72 pp. *Reptiles and Amphibians of the San Francisco Bay Region.* Robert C. Stebbins. 72 pp. University of California Press, San Francisco, 1959. $1.50 each.

Mathematics for the Academically Talented Student in the Secondary School. Report of a conference. Julius H. Hlavaty, Ed. 48 pp. $0.60. *Mathematics Tests Available in the United States.* Sheldon S. Myers. 12 pp. $0.50. *A Guide to the Use and Procurement of Teaching Aids for Mathematics.* Emil J. Berger and Donovan A. Johnson. 41 pp. $0.75. National Council of Teachers of Mathematics, National Education Association, Washington, 1959.

Natural Aerosols and Nuclear Debris Studies. Progress report No. 1. GRD Research Notes No. 8. ASTIA Documents No. 8. ASTIA Documents No. AD 209-539. Atmospheric Circulations Laboratory, Geophysics Research Directorate, U.S. Air Force, Bedford, Mass., 1959 (order from Armed Services Information Agency, Document Service Center, Dayton 2, Ohio). 45 pp.

Notes on Plants and Plant Habitats Observed in the Abydos-Woodstock Area, Pilbara District, Western Australia. Division of Plant Industry technical paper No. 12. Nancy T. Burbidge. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1959. 16 pp.

The Spectrum of Beta Lyrae. Transactions, vol. 49, pt. 1. J. Sahade, S.-S. Huang, O. Struve, V. Zebergs. American Philosophical Soc., Philadelphia, Pa 1959. 64 pp. $2.

Symposium on Metabolism. Quarterly, vol. 19, No. 3. Chicago Medical School, Chicago 12, Ill., 1958. 48 pp.

Why Should You Study Physics in High School? American Institute of Physics, 335 East 45 Street, New York, 1959. 16 pp.

World Directory of Veneral-Disease Treatment Centres at Ports. World Health Organization, Geneva, Switzerland, 5th list, 1959. 159 pp. $1.75.

Reports

Density-Gradient Centrifugation with Infectious Ribonucleic Acid of Foot-and-Mouth Disease Virus

Abstract. The sedimentation constant of an infectious component in ribonucleic acid preparations from foot-and-mouth disease virus has been determined by density-gradient centrifugation. A sedimentation constant of 37 Svedberg units (S_f) was obtained. On the assumption that the relation between the molecular weight and the sedimentation constant found by Gierer is applicable to our system as well, a value of 3.1×10^6 was calculated for the molecular weight of the infectious component.

In an earlier study (*1*) we obtained infectious ribonucleic acid (RNA) preparations from the tissues of suckling mice infected in vivo with foot-and-mouth disease virus, type C. The method employed in these investigations was that of Gierer and Schramm (*2*). The isolation of infectious RNA preparations from four animal viruses has been described by others (*3*).

The infectious component in the RNA preparations from foot-and-mouth disease virus differed in some properties from the intact agent.

Recently, Gierer (*4*) was able to calculate from sedimentation and intrinsic viscosity measurements the molecular weight of the RNA from tobacco mosaic virus. It was found to be approximately 2×10^6. This finding encouraged us to determine the sedimentation constant of the active unit in our RNA preparations and to calculate from this value the molecular weight of the active unit.

The virus strain used in this study was type C. The method of Gierer and Schramm (*2*) was employed for the preparation of infectious RNA. The RNA preparations were centrifuged at 35,000 rev/min (95,000*g*) for 5 minutes, and the supernatant was used for determination of the sedimentation constant by density-gradient centrifugation. This centrifugation method was developed because the active unit to be investigated was very labile and made up only a small part of the total RNA content of the preparation. The centrifugations were carried out in a Spinco ultracentrifuge, model L, with a swinging-bucket rotor SW 39. We employed Plexiglas (plastic) cells with a sector-shaped chamber. The chamber had a volume of 1.8 ml and was 3.7 cm high. During the centrifugation the bottom of the chamber was 9.1 cm from the axis. These plastic cells fit in the buckets of the rotor and were manufactured in our workshop. Gradient columns each 6-mm thick were prepared of D_2O—H_2O mixtures containing 90, 76, 61, 44, and 25 percent D_2O, respectively. The *p*H of the mixtures was stabilized with 0.02*M* phosphate buffer. The loaded cells were held at 4°C for 1 hour, then a sample of a RNA preparation was floated on the column. The cells were centrifuged 110 and 130 minutes at 38,000 rev/min (about 112,000*g*) and 35,000 rev/min (about 95,000*g*), and the rates of acceleration and retardation were taken into account. The values of $\omega^2 t$ in the different experiments were in the range from 9.85×10^{10} sec^{-1} to 16.75×10^{10} sec^{-1}. The refrigerator was adjusted so that the rotor had a temperature of 6°C during the whole run. Afterward, the centrifugation samples were removed, in steps, with a special capillary pipette and used for infectivity assay in suckling mice (intracerebral), ultraviolet absorption, and specific-density measurements.

The active unit was detected within a relatively narrow zone. A point in this zone above and below which the same number of infectious units had been found ("mean point") was determined.

The value of the sedimentation constant (s_{20} was calculated from the equation

$$s_{20} = \frac{\sigma - \rho_0^{20}}{\eta_0^{20}} \times R_0 \frac{\int_{R_0}^{R_t} \frac{\eta_R}{(\sigma - \rho_R) \cdot R} \cdot dR}{\omega^2 t}$$

in which σ (1.67 g/ml) represents the specific density of RNA; ρ_0^{20} and η_0^{20} are the specific density and viscosity, respectively, of water at 20°C; ρ_R and η_R are the specific density and viscosity, respectively, of the gradient as a function of the radius; R_0 and R_t are the radii of the "mean point" before and after the run, respectively; ω is the angular velocity; and t is the time.

Functions ρ_R and η_R were determined in a sector-shaped diffusion cell, and the integral was calculated numerically.

In control experiments with hemocyanin from *Helix pomatia* a mean s_{20} of 105 S_f was obtained in an analytical ultracentrifuge, while density-gradient centrifugation furnished a value of 104 S_f, indicating the remarkable accuracy of the method.

The mean s_{20} value of the infectious unit in the RNA preparations obtained from foot-and-mouth disease virus was 37 S_f.

If one assumes that the infectious unit in our RNA preparations has the same structure as the RNA of tobacco mosaic virus, the relationship between the sedimentation constant and the molecular weight found by Gierer (*4*) may be used for calculation of the molecular weight of the infectious unit. A value of 3.1×10^6 was obtained.

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2 February 1959

Instrumental Conditioning of Lemon Sharks

Abstract. Two sharks were trained to feed at a target which, when pressed, caused a submerged bell to ring. Later they were trained to press the target for remotely placed food. They retained this conditioned response after a 10-week period of inactivity.

Captive sharks, like other fishes, quickly learn to go to the place where they are usually fed. Experiments were conducted to determine the extent to which they could be conditioned to more complex situations (*1*).

The sharks used were a male and female lemon shark, *Negaprion brevirostris* (Poey), each about 3 m long. They had been in captivity over 4 months and were healthy and active. They were

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Table 1. Weekly summary of number of bell rings by five sharks.

Week No.	Total for two lemon sharks			Total for three nurse sharks			Place of food†	Av. water temp. (°C)
	Rang bell, got food	Rang bell, missed food	Food "stolen"*	Rang bell, got food	Rang bell, missed food	Food "stolen"*		
1	70	11	0	5	0	(3)	0	29
2	99	10	0	8	0	(4)	0	28
3	88	25	0	15	0	(2)	0	27
4	101	14	0	11	1	(21)	0	25
5	80	23	0	9	4	(36)	0	23
6	70	26	0	31	5	(9)	0	22
Total	508	109	0	79	10	(75)		
7	27	57	2	15	13	2	66	23
8	56	65	12	7	12	1	96	23
9	56	94	39	5	8	8	126	23
10	35	73	31	0	2	13	156	24
11	27	32	15	0	2	6	216	21
12	18	24	6	0	1	12	216	21
13	4	9	3	0	0	1	246	17
14	0	0	0	0	0	0	246	17
Total	223	354	108	27	38	43		
Grand total	731	463	108	106	48	118		

* Food "stolen" after another shark rang bell. Figures in parentheses represent food sucked off target without a ring. † Distance (in centimeters) from center of target.

housed in a 12- by 18-m pen, adjacent to the laboratory dock, with three nurse sharks, *Ginglymostoma cirratum* (Bonnaterre), of about the same size (males).

During a 6-weeks' training period the sharks were fed five times a week, Monday through Friday, at approximately 3:15 P.M. At this time a target was lowered into the water, and it was removed at the end of the feeding period. (It was never put into the water at any other time.) The target was made of a piece of plywood 41 cm square and painted white. When the target was pressed it caused a submerged bell to ring.

For the first 2 days of the training period pieces of food were thrown to the sharks near the target. Gradually the food was thrown closer to the target. On the third day, and for the rest of the 6 weeks, the food was tied to the center of the target on a short, weak string. In order for the lemon sharks to feed, they were forced to press their snouts against the target. Food was on the target when it was first lowered into the water, and as a shark removed the food, another piece was supplied.

At the beginning of the seventh week, an empty target was lowered into the pen at the regular feeding time. When a shark pressed the target hard enough to ring the bell, a piece of reward food attached to a string was dropped into the water. The shark was given 10 seconds to get this food, and if he did not succeed, the food was then pulled out of the water. Each week the food was dropped farther away from the target.

The results of these feedings are summarized in Table 1. During the training period the lemon sharks rang the bell and successfully obtained food at the target 508 times; they rang the bell but missed the food 109 times. In contrast to the lemon sharks, who, on approaching the target, only slowed down in an effort to take food from it, the nurse sharks would approach the target from below, hover beside it, and move their oral barbels along the target's surface. When they had located the food, the nurse sharks often were able to suck the food off the target without pressing the target hard enough to ring the bell. This they did a total of 75 times. They rang the bell and took food at the target 79 times and missed the food after a ring only ten times. The latter score also reflects their ability to hover before the target.

The first time the sharks were confronted with an empty target, the male lemon shark approached it in less than half a minute after it was lowered into the water. When he reached the target he slowed down and merely brushed the target, without pushing it hard enough to ring the bell. After repeating this maneuver nine times, he finally pressed the target sufficiently hard to ring the bell, and food was immediately dropped into the water. The male quickly learned to press the target for reward food, and by the end of the week both the male and the female lemon sharks were successfully conditioned to pressing the empty target and returning for food. The individual scores for the male and the female were closely alike and will be analyzed elsewhere.

The data accumulated in the weeks of testing with the empty target are shown in the lower portion of Table 1. The nurse sharks did not appear to make a strong association of the target with food. At first they came to the target, but then they started to spend more time hovering under the food and frequently took the food dropped after a lemon shark had rung the bell. The lemon sharks also took food from each other. When one shark rang the bell and another shark took the food we scored this as a "steal" for the shark that got the food.

When the water temperature dropped below 24°C the sharks fed less, and by mid-December they lost interest in food offered to them in any manner. Until this time, however, the lemon sharks rang the bell and got the remotely placed food 223 times; they rang the bell but missed the food 354 times; they "stole" food 108 times. The nurse sharks rang and got food 27 times, rang but missed the food 38 times, and "stole" food from the lemon sharks 43 times. The presence of nurse sharks hovering around the feeding place led to frequent collisions among the sharks.

There was a strong tendency for the male lemon shark to approach the target first at each feeding period. Scores were kept of the chronological order of approach during 53 feeding periods, during which time the lemon sharks rang the bell 1117 times. The male rang first 50 times and the female, three times. Of the first three rings made during each of these feeding tests, 134 were made by the male and only 25 by the female. As the female was placed in the pen several weeks before the male, prior residence was not a contributing factor in what may be social dominance of the male. "Fighting" among the sharks has never been observed. We have no evidence yet in explanation of the fact that the female refrains from pressing the target until the initial hunger of the male apparently is satisfied.

The sharks retained these conditioned responses through the midwinter cold spell. When the temperature rose to over 20°C again, the sharks readily pressed the target when it was presented to them, even though they had not seen it for a period of 10 weeks.

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Notes

1. I wish to acknowledge with gratitude valuable help given me in this work. Dr. Lester Aronson made important suggestions in the initial planning of these experiments. I was fortunate to receive the benefit of suggestions from Dr. Charles M. Breder, Jr., who happened to be here during various stages of this study. Captain Oley Farver caught and handled the sharks used.

20 April 1959

Coiling Direction of Globigerina pachyderma as a Climatic Index

Abstract. An interdependence between the geographical distribution of dextral and sinistral populations of the planktonic foraminifer, *Globigerina pachyderma,* and sea surface-temperatures is demonstrated. It is inferred that changes in dominant coiling direction at lower levels in sediment cores from the North Atlantic record southward shifts of isotherms during the last ice age.

Variation in coiling direction of planktonic foraminifera has been studied by Bolli (*1*), by Vašíček (*2*), and by Ericson, Wollin, and Wollin (3). Vašíček (*2*) and Nagappa (*4*) have utilized their findings on this subject in making stratigraphic correlations between various oil wells. Ericson, Wollin, and Wollin have charted the geographical distribution of populations of *Globorotalia truncatulinoides* (d'Orbigny) in top samples from sediment cores taken in the North Atlantic Ocean. From evidence that the pattern of distribution of these populations has persisted for some thousands of years, probably since the end of the last ice age, they infer that there must be something about the local environment which works to the advantage of those individuals which coil in the preferred direction. However, just what this selective condition of the environment may be is far from clear from the pattern of distribution of *G. truncatulinoides.*

In the case of *Globigerina pachyderma* (Ehrenberg), on the other hand, an interdependence between surface water temperature and coiling direction is evident from Fig. 1, which shows percentages of right and left coiling in top samples from sediment cores taken in the Arctic Ocean, the North Atlantic Ocean, and connecting seas. The percentages have been determined from counts of at least 100 tests in each sample. The position of 7.2°C isotherm in April (*5*) is also shown.

A similar relationship between coiling and temperature has been found in the South Atlantic Ocean. Although not enough samples have been studied to define a boundary line, it is apparent that left coiling is strongly dominant in samples from the vicinity of Antarctica and south of latitude 50°S, while right coiling is dominant in samples from points farther north.

To conceive of any mechanism by which temperature could act selectively upon coiling direction is difficult, to say the least.

The explanation may be, as suggested by Ericson, Wollin, and Wollin (*3*), that the advantage enjoyed by individuals having the preferred coiling direction is not due to a direct reaction between the geometry of the tests and the environment, but rather to genetical linkage between coiling direction and some other characteristic of the animal which, in the case of *Globigerina pachyderma,* determines temperature tolerance.

Coiling ratios in samples from lower levels in the cores show that left coiling has been strongly dominant from top to bottom of all cores taken within the present province of left coiling, and that in cores from the right-coiling province there have been several reversals in the dominant direction. In short, during late Pleistocene time the boundary between the provinces of right and left coiling was never much farther north than it is now, but at other times it was a good deal farther south. Changes in the ratio of coiling directions in a typical core, R9-7, from the right-coiling province are shown graphically in Fig. 1, together with a curve of climatic change inferred from variation in abundance of all other species of planktonic foraminifera in samples taken at 10-cm intervals. The record suggests that there has been a relatively recent shift of isotherms to the north and that the immediately preceding time of cold climate was, in turn, preceded by a rather short interval, recorded at 50 and 60 cm in core R9-7, during which the April 7.2°C isotherm was at or near its present position.

In general, the distribution of other species of planktonic foraminifera in the cores is in harmony with the supposition that the changes in coiling of *Globigerina pachyderma* are influenced by temperature. For example, no species of *Globorotalia* occur at any level in cores taken in the Norwegian, Greenland, and Arctic seas, and these species are poorly represented in top samples of cores from more

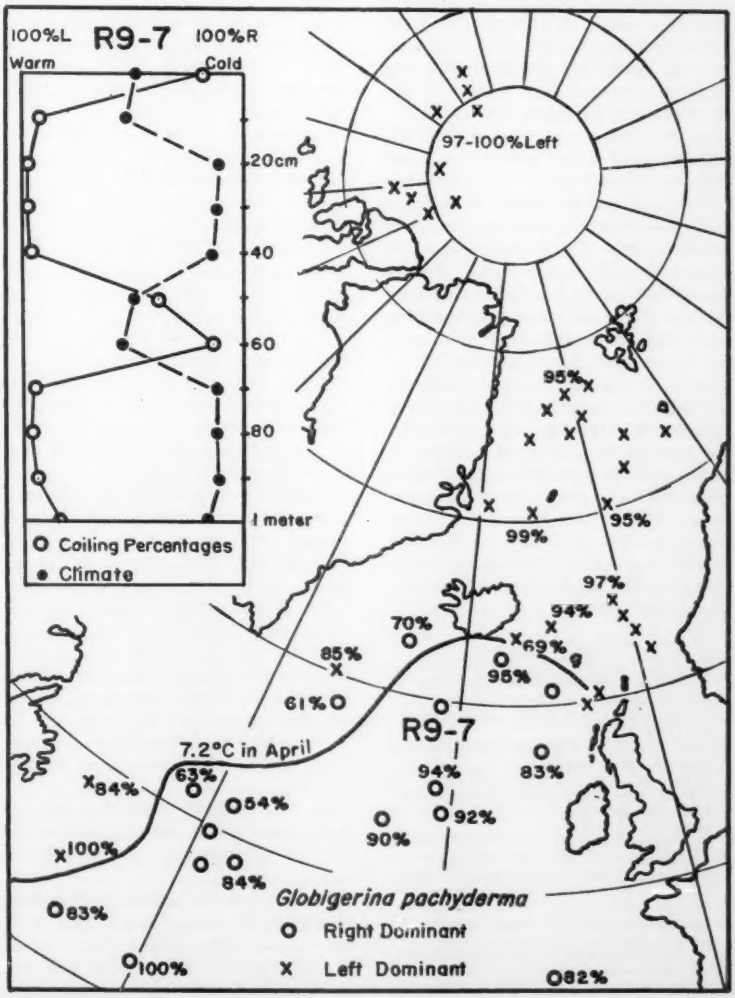

Fig. 1. Distribution of dextral and sinistral populations of the foraminifer, *Globigerina pachyderma,* in top samples of sediment cores and the position of the 7.2°C surface temperature isotherm in April.

southerly stations within the province of left coiling. They are abundant, however, in the tops of cores from the province of dextral coiling. The same association is maintained in the time dimension of cores from the province of dextral coiling; species of *Globorotalia* are well represented in sediments layers where the coiling of *Globigerina pachyderma* is dominantly dextral, but they are absent or rare where the coiling is sinistral.

By determining similar vertical changes in coiling percentages of *G. pachyderma* in cores from more southerly stations not shown on the chart it will probably be possible to determine approximately the former position of the boundary between right and left dominant populations, and by inference the most southerly position of the April 7.2°C isotherm during the peak of the last glaciation. This information will make possible an estimation of the amount of temperature lowering that occurred in this part of the North Atlantic during the last ice age.

In the meantime, the present data are at least suggestive. The absence of any zone of right coiling at lower levels in the cores from the province of left coiling implies that this part of the North Atlantic during the late Pleistocene has not at any time been much warmer than it is now. Evidence that the boundary between right- and left-coiling populations was farther south during the last ice age favors the conclusion that continental glaciation was accompanied by general cooling of North Atlantic waters, and particularly within this critical region, rather than by marked change in pattern of circulation. This conclusion supports the hypothesis that Pleistocene refrigeration was a result of reduction in total radiation from the sun and not a consequence of some purely terrestrial cause (*6*).

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6. This report is Lamont Geological Observatory contribution No. 355. The investigation is being supported by National Science Foundation grant No. NSF-G6540. I am grateful to Maurice Ewing, director of the Lamont Geological Observatory, who made available the material described in this communication. O. L. Bandy, University of Southern California, has informed me that he has a paper in press which also deals with the coiling of *Globigerina pachyderma*. According to Bandy our respective papers will supplement rather than duplicate each other.

9 April 1959

Virus versus Gene Change in Maize

In maize the *Rrr* kernels from a standard RR♂ × rr♀ (*R*, self-colored aleurone; *r*, colorless aleurone) are dark-colored. However, Brink (*1*) has found that when plants of genotype RR^{st} (R^{st}, stippled aleurone) are test-crossed on *rr*♀, the resulting kernels which receive *R* (from their RR^{st} parent) have aleurone which is weakly-colored mottled. We might indicate these kernels as *R′rr*; the prime indicates *R* of RR^{st} origin, without commitment whether *R′* is different from *R*.

Brink explains the weakly-colored mottled phenotype of *R′rr* kernels on the assumption that in the RR^{st} parent the R^{st} gene causes *R* to mutate, at a 100-percent rate, to a gene ($R^{r:st}$) for weakly-colored mottling (an effect referred to by Brink as "paramutagenesis"). The R^{st} gene itself is apparently unaffected in RR^{st}. When weakly-colored mottled kernels (*R′rr*) from the test cross of the RR^{st} parent are again test-crossed, the resulting *R′rr* kernels are again weakly-mottled. Brink has therefore concluded that *R* is actually altered in the original RR^{st} parent, since the test-cross progeny (*R′rr*) maintain their light color from one generation to the next. On the other hand, when RR^{st} is self-fertilized, the resulting kernels which have at least two doses of *R′* in their aleurone (*R′R′*R^{st} or *R′R′R*; $R^{r:st}R^{r:st}R^{st}$ or $R^{r:st}R^{r:st}R^{r:st}$, according to Brink's hypothesis), have aleurone almost as dark as that of standard *RR* plants. Brink has therefore concluded that in the kernels under discussion, his $R^{r:st}$ gene reverts, at a 100-percent rate, almost completely to *R*.

In order to rule out the theory that a virus (or other plasmid element) is causing the changed expression in the *R′rr* kernels, Brink crossed the plants grown from these kernels to standard *RR*♂. The resulting *Rrr* kernels would, of course, be the product of an *R* gamete from the *RR* parent and an *r* gamete from the *R′rr* parent. If the latter (*R′rr*) carried a virus, its *r* gametes might also be expected to carry the virus and to transmit it to the *Rrr* kernels in the cross *R′rr*♀ × *RR*♂. However, these kernels are dark, like *Rrr* of standard origin. Brink has therefore concluded that no virus is involved in the changed expression in *R′rr* kernels (weakly-colored mottled).

However, in my opinion this finding relative to the cross *R′rr*♀ × *RR*♂ does not exclude the possibility that a virus is changing the aleurone from dark red to light in the *R′rr* kernels (those derived from RR^{st}♂ × *rr*♀). Conceivably, two substances, *A* and *B*, are necessary for the continued existence of the virus. Gene R^{st} produces both and supports the virus; *R* produces *A* but not *B*; *r* produces *B* but not *A*. Moreover, we must assume that the virus rapidly disappears in a cell which lacks *A* but that it may live for a longer time in a cell which lacks *B* but has *A*, or may even linger on for several generations, largely in an inactive state, in plants which have only *A*. The virus therefore could not be transmitted by the *r* gametes of a plant that grew from an *R′rr* kernel, but it could be transmitted by the *R′* gametes. If the latter fertilized an *rr*♀ (giving *R′rr* kernels), gene *R* would supply the *A* element and *r*, the *B*. The virus would therefore persist, and the kernels would be light (instead of dark, as they would be in the absence of the virus).

Until further tests, involving properly marked chromosomes have been made, it might be well to suspend judgment on the significance of Brink's RR^{st} case in maize (*2*).

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2. This study was supported by a grant (C-2393) from the National Institutes of Health, U.S. Public Health Service.

26 March 1959

Reflectivity Spectrum and Optical Constants of Bituminous Coal; Estimation of Aromaticity

Abstract. The spectra of reflectivities, refractive indices, and absorption indices of a bituminous coal vitrain have been determined for the ultraviolet-visible spectral region. The low values for these quantities support the premise that polynuclear condensed aromatics may be present in coal only in small amounts. Aliphatic and amorphous carbons may predominate.

The spectra of specular reflectivities have been determined in the ultraviolet-visible region for Bruceton coal vitrain (*1*), which is 84 percent carbon. Previously, the absorption spectrum in this

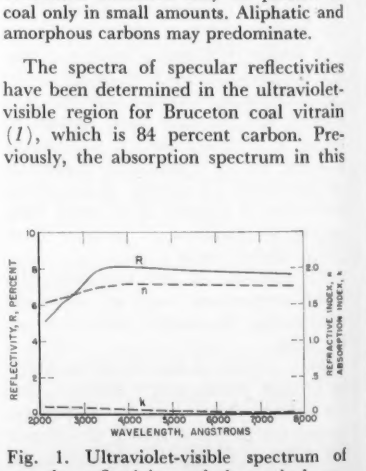

Fig. 1. Ultraviolet-visible spectrum of specular reflectivity and the optical constants, n and k; Bruceton vitrain.

Table 1. Reflectivities (R), specific extinction coefficients (K), and the optical constants, refractive index (n), and absorption index (k), of Bruceton vitrain.

λ (A)	K	k	R (%)	n
7750	0.8	0.006	7.66	1.766
7000	1.2	0.011	7.69	1.767
6000	2.5	0.020	7.75	1.771
5461	3.7	0.026	7.88	1.779
5000	5.4	0.035	7.93	1.781
4000	10.0	0.052	8.11	1.788
3500	14.5	0.066	8.02	1.778
3000	20.0	0.079	7.17	1.715
2750	23.0	0.088	6.49	1.664
2500	24.0	0.086	6.04	1.633
2200	28.0	0.093	5.37	1.583
2150	29.0	0.093	5.13	1.563

region was reported along with calculated absorption indices, k (*2*); the value for k at 5461 A was found to be appreciably smaller than published values obtained from reflectivity measurements (*3, 4*). From the reflectivity spectrum (Fig. 1), refractive indices, n, over the entire spectral region have been calculated (Table 1) by Fresnel's equation

$$R = \frac{(n-1)^2 + n^2k^2}{(n+1)^2 + n^2k^2}$$

Because of the low magnitude of the absorption indices, this quantity is nearly insignificant in the calculation of refractive indices. However, the interdependence of the two indices was taken into account by successive alternate calculations of refractive indices from the above equation and of the absorption indices from

$$k = \frac{2.303\,\lambda\,A}{4\pi x n}$$

where λ is the wavelength of light in centimeters, A is the absorbance, and x is the sample thickness in centimeters.

The experimental reflectivity curve remains smooth throughout the spectrum, with no sharp discontinuities. One weak, broad shoulder appears at 2650 A. The reflectivity and refractive index spectra decrease appreciably at short wavelengths in the ultraviolet region. This decrease may be due to changes in absorption properties in this region, but it is more probably due to increased scattering of the coal substance at these wavelengths.

Reflectivity measurements were made on polished pieces of Bruceton vitrain with a Cary spectrophotometer equipped with a specular reflectance attachment; a front-surface aluminized mirror was used as the comparison, and reflectivity values for fused quartz were used as spectral standards.

Aromaticity of coal. In regions of strong spectral absorption, an increase is expected in both the refractive index and the absorption index, and hence in the reflectivity. In coal, such marked increase in absorption does not occur anywhere in the ultraviolet-visible spectrum (*3*). As can be seen from the data for reflectivity and refractive index, there also is no substantial increase in these values at any place in the spectrum.

These data are of particular significance in view of the recent reevaluation of x-ray measurements (*5*) which indicate that the ring sizes of aromatics that may be in Bruceton vitrain should be 1-to-3 and 2-to-4 rings. Thus the possible condensed aromatic nuclei are limited to 2-to-4 rings such as are found in naphthalene, phenanthrene, fluorene, chrysene, and other compounds. The strongest absorptions of all of these are confined to a narrow region of the short-wavelength ultraviolet, so that both reflectivity and absorption should show marked increases with definite spectral fine structure in this narrow region, but they do not. Most of the 16 2-to-4-ring polynuclear condensed aromatics, naphthalene through pyrene, have their strongest band in the region 2100 to 2550 A with K values from 205 (fluorene) to 1230 (anthracene). Five of the 2-to-4-ring group have their maximum absorption band between 2550 and 2750 A with K values from 360 (2,3-benzofluorene) to 1640 (naphthacene). On the basis of K values, the allowable percentages of these compounds that could be present in Bruceton vitrain varies from 1.4 to 14 percent. These maximum percentages of individual aromatics are not additive owing to considerable overlapping interference in this short spectral region.

If the principal structures in bituminous coal vitrain are not polynuclear condensed aromatic in nature, the predominant structures may be aliphatic and alicyclic and/or benzenoid. The shortage of hydrogen, oxygen, and other elements may require that the saturated structures contain extensive systems of tetrahedral carbon-carbon bonds—that is, quaternary carbon atoms in diamond-like structures of small size or in amorphous carbon structures like the "vitron" suggested for glass (*6*).

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24 February 1959

On the Presence of Fixed Ammonium in Rocks

Abstract. From one-fourth to one-half of the nitrogen in some granite rocks, and up to two-thirds of that in some paleozoic shales, occurred as ammonium ions held within the lattice structure of silicate minerals. The results provide greater insight into the origin of the earth's atmosphere.

It has been assumed by many scientists that practically all of the nitrogen in rocks occurs in organic combination. Evidence for this assumption has been based on the fact that only a small fraction of the nitrogen in rocks could be recovered as ammonia or nitrate by leaching with base-exchange reagents. Research conducted recently by my coworkers and me (*1, 2*) has shown that soils contain considerable amounts of fixed ammonium (ammonium ions held within the lattice structure of silicate minerals), and it seemed reasonable to postulate that some of the nitrogen in rocks is fixed ammonium. The purpose of this study was to test this hypothesis (*3*).

A procedure based on the ability of HF to remove fixed ammonium from clay minerals has been developed by Dhariwal and Stevenson (*1*) for the determination of fixed ammonium in soils. This method was modified for the determination of fixed ammonium in rocks. The procedure adopted was as follows: a 0.5- to 1.0-g sample of finely ground rock (100 mesh) was treated with 20 ml of boiling 1*N* KOH for 6 hours. The residue was recovered by centrifugation in a polyethylene tube, washed free of KOH with ammonia-free water, and treated with 10 ml of a solution consisting of 7.5*N* HF and 1.0*N* HCl. For granite rocks, the mixture was transferred to a polyethylene beaker and heated on a hot plate at 80°C to near-dryness. The ammonium released by HF was distilled with alkali into standard acid. The ammonia was estimated colorimetrically, by means of Nessler's reagent.

Total nitrogen in the samples was determined by a micro-Kjeldahl procedure. The digestion time was 3 hours.

The specimens included several Paleozoic shales and granite rocks. The shales were from Illinois. Shales A, B, and C were from Mississippian horizons; shale D was from a Pennsylvanian horizon. Granite rocks A, B, and C were from outcrops. Rock A was from New Hampshire, rock B was from Maine, and rock C was from Vermont (from the Rock of Ages quarry). Granite rocks D, E, and F were Pleistocene boulders from glacial till of Wisconsin age. They were obtained from Vermilion County, Ill. (*4*).

The total nitrogen and fixed ammonium nitrogen contents of the speci-

Table 1. Fixed ammonium nitrogen in shales and granite rocks.

Sample	Total N (μg/g)	Fixed $NH_4^+ - N$ (μg/g)	Fixed $NH_4^+ - N$ (% of N)
Shales			
A (1445–1449 feet)	500	330	66.0
B (1976–2018 feet)	810	420	51.9
C (2318–2329 feet)	680	420	61.8
D (596– 600 feet)	610	410	67.2
Granite rocks			
A (highly weathered)	86	27	31.0
B (slightly weathered)	35	10	28.6
C (unweathered)	32	18	56.3
D (moderately weathered)	26	9	34.6
E (moderately weathered)	21	5	23.8
F (moderately weathered)	37	10	27.0

mens are given in Table 1. The nitrogen contents of the granite rocks were generally lower than the values reported by Rayleigh (*5*) for igneous rocks. The results show that all of the samples contained nitrogen, which was not removed by boiling 1*N* KOH but was released as ammonia by HF. As hydrofluoric acid dissolves silicate minerals, there can be little doubt that the nitrogen occurred as fixed ammonium. Indirect evidence for the presence of fixed ammonium in rocks is provided by the study of Rayleigh (*5*), who found that the nitrogen in igneous rocks was liberated as ammonia by heating with caustic soda, but not with caustic potash. It is now known that caustic soda expands the *d* (001) spacing of silicate minerals, thereby allowing the ammonium ions to escape; caustic potash contracts the *d* (001) spacing, thereby preventing their release (*1*).

The origin of the fixed ammonium in the granite rocks must be regarded as a subject for speculation. The silicate minerals in granite rocks have crystal lattices that are contracted and incapable of fixing ammonium. I am of the opinion that ammonium was present in the substrate at the time the minerals were synthesized and competed with potassium for the pockets formed by the hexagonal oxygen rings in the crystalline nuclei of the minerals.

The nature of the nitrogen in the granite rocks that was not recovered as fixed ammonium is not known. Ammonia was liberated from rocks A, B, D, E, and F during the treatment with boiling 1*N* KOH. This nitrogen could have been in the form of exchangeable ammonium produced through the release of fixed ammonium from silicate minerals during weathering. The observation of Engols and Navarre (*6*) that substantial concentrations of ammonia nitrogen occur in unpolluted surface and ground waters of the uplands of northern Georgia as a result of the leaching of granite rock undergoing rapid weathering can be attributed to the liberation of ammonium ions from silicate minerals through weathering.

It is of interest to consider some possible inplications of the results obtained from this study. First, they indicate that a vast reservoir of nitrogen exists in the terrestrial areas of the earth as ammonium ions held within the lattice structure of silicate minerals. The amount of combined nitrogen in the silicate phase of the primary lithosphere of the earth has been estimated to be about 50 times the amount present as gaseous nitrogen in the atmosphere (*5, 7*); the amount of nitrogen in sedimentary rocks has been estimated as about one-sixth that in the atmosphere (*7, 8*). If it is assumed that an average of one-third of the nitrogen in igneous rocks, and one-half of that in sediments, is fixed ammonium, the amount of nitrogen present as fixed ammonium in the earth's crust would be almost 20 times that present as elemental nitrogen in the atmosphere.

Second, the results provide a clue to the origin of nitrogen in the atmosphere. Scientists generally believe that the nitrogen content of the atmosphere increased during geologic times, presumably through de-gassing of the earth (*7, 9*). It has been known for a long time that nitrogen is given off during the heating of igneous rocks. This has led to the conclusion that the nitrogen in volcanic gases is primary and thus is a new addition to the atmosphere. Scott *et al.* (*10*) found that fixed ammonium ions in some clay minerals were released at temperatures as low as 400°C; this is well below the temperatures reached in volcanoes.

Third, the results afford an explanation of the chemical nature of the nitrogen in stony meteorites. Biddhue (*11*) found that the fusion of meteorite powder with caustic soda and mercuric nitrate resulted in the production of ammonia. This ammonia was believed not to be entirely in the free state. Nitrogen is liberated from stony meteorites during entry into the earth's atmosphere, and I postulate that some of it originates as ammonium ions held within the lattice structure of silicate minerals.

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9 March 1959

Changes in Soluble Citrate of Pigeon Bone during Egg Laying

Abstract. Accompanying the structural changes in medullary bone during the egg-laying cycle there are local increases in the concentration of soluble citrate. Since citrate can form both soluble and insoluble compounds with calcium, it is suggested that this anion may have a regulatory function in bone apposition and resorption.

Bone is a highly organized aggregate composed mainly of a protein matrix, apatite, water, and electrolytes. Like other tissues, it responds readily to changes in the composition of the surrounding body fluids and to the metabolic activities of the neighboring cells. Notable examples of this lability are the metaphyseal dissolution which follows the administration of parathyroid extract and the changes in avian medullary bone during egg laying.

We have suggested that resorption of bone could be initiated by the accumulation of intermediate metabolites formed by the contiguous connective tissue cells (*1, 2*). In support of this theory it was shown that, after the administration of parathyroid extract in the rabbit, dehydrogenase activity of bone slices was diminished and respiration was impaired (*2*). In this circumstance, the anions of di- and tricarboxylic acids could accumulate at physiologic *p*H, dissolving calcium from the apatite crystal and competing for calcium with the fixed colloidal anions of the bone matrix (*3*). The formation of these soluble calcium complexes would thus contribute to the dissolution of the structure.

We agree with others that, of the tricarboxylic acid anions, special attention should be accorded to citrate (*4–7*). There are several reasons for this emphasis. (i) The dissociation constant of calcium citrate is very low, and hence

the solution of insoluble calcium salts is favored in the presence of this anion (*8*). From experiments on the equilibration of apatite systems and of powdered bone with buffered citrate, it is evident that soluble (and insoluble) complexes are formed with bone mineral (*5, 6, 9*). (ii) Citrate occupies a position of central importance in the scheme of cellular metabolism, and bone contains the enzyme systems necessary for the synthesis and utilization of this compound (*2, 4*). (iii) Citrate occurs in relatively high concentration in the extracellular matrix of bone (*10*). (iv) An elevation of serum citrate levels often accompanies bone resorption (*11, 12*).

In testing our theory, we studied soluble citrate concentrations in medullary bone of the pigeon during the egg-laying cycle (*13*). At such times, rapid transformations occur in the tibia and femur (*14*). For approximately 1 week preceding calcification of the egg, a period of bone apposition is dominant. Then during calcification of the egg (a clutch of two eggs is laid within 40 hours) resorption predominates, and the serum citrate level is elevated (*12*). In the third stage, this cyclic activity is discontinued and bone apposition and resorption are minimal. The soluble citrate concentrations were determined during these three stages.

Previous efforts to demonstrate local changes in citrate concentration in bone have been clouded by the inclusion of a large quantity of citrate from the insoluble extracellular phase (*15*). We have attempted to overcome this difficulty by a procedure which largely sequesters cells and soluble extracellular material. Hence, our results measure intracellular citrate plus any liberated soluble extracellular fraction.

Thirty pairs of mated pigeons were used for these experiments. The birds were examined daily until their egg-laying cycle was determined. They were then sacrificed during the resting, apposition, or resorption period. The exact period was confirmed by gross examination of the ovaries and ovulatory tract and by gross and histologic examination of the long bones. Material for citrate determination was obtained from the tibia and femur. For this procedure the bones were excised and split longitudinally, and the cells in the medullary portion were aspirated through a fine-bore (1 mm) glass tube into a chilled flask containing a small amount of distilled water. A piece of 100-mesh wire screen, moistened with water, was interposed between the bone and the tip of the tube to prevent aspiration of bone particles. The surface of the bone was continually shaved with a razor blade to expose fresh areas of cells. The aspirated material was homogenized and then lyophilized.

Table 1. Soluble citrate aspirated from pigeon medullary bone.

No. of birds	Stage	Citric acid* (μg/g)	*P*
8	Resting	167 ± 82	
7	Apposition	846 ± 203	
15	Resorption	1361 ± 304	< .001

* Mean values and standard deviations expressed as micrograms per gram of lyophilized material.

Fifty-milligram portions of the dried material were analyzed for citric acid by L'Heureux and Roth's modification of the method of Natelson, Pincus, and Natavoy (*11*).

The results, expressed as micrograms of citric acid per gram of dry aspirated material, are given in Table 1. During the resting phase the citrate level was 167 μg/g. This level increased about five times during the stage of bone apposition. The highest concentration, representing an eightfold increase over the resting level, occurred in the resorptive stage.

These values may be compared with the citrate concentration in the serum (approximately 5.7 mg/ml) observed during the resting stage (*12*). To express the data in terms of tissue water, we will assume that the extracted cellular material has a water content of 80 percent. Then the calculation yields the following values: resting stage, 4.2 mg/100 ml; appositional stage, 21.2 mg/100 ml; and resorptive stage, 34.0 mg/100 ml. Thus, the concentration of citrate from the bone sites during the cycle exceeds that in serum from resting birds by approximately 4 to 6 times. We have no information about the rate of formation and utilization of citrate by the bone; nevertheless, this high local citrate concentration alone would be expected to have an important effect on the state of the bone salts and bone matrix.

In in vitro experiments with calcium phosphate, apatite, and bone powder, it has been shown that citrate can react with calcium to form both soluble and insoluble compounds (*6, 9*). When a small amount of citrate is present, it is coprecipitated with calcium phosphate (or apatite). On the other hand, larger concentrations lead to the formation of soluble calcium citrate and to solubilization of the altered apatite. Although the nature and relationships of many of the components and phases of bone are still ill defined, we assume that in bone, citrate is also distributed between an insoluble phase in the calcified matrix and a soluble phase, as a calcium complex. This concept, in conjunction with our present and earlier experimental observations, leads to the following hypothesis concerning the role of citrate in bone apposition and resorption. During bone formation, the citrate released through cellular metabolism is largely deposited in the insoluble solid phase. As citrate production continues and the concentration increases, the soluble calcium citrate complex is formed, removing calcium from the ionic, crystalline, and protein bound fractions. Accompanying this realignment in the phase relations there is a disaggregation of the structure of bone. As a corollary of this view, the role of citrate in cell metabolism and its equally significant part in bone apposition and resorption illustrates the unity of structure and function.

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6 March 1959

Display of Moving Parts of a Scene

Abstract. Methods for emphasizing the moving parts of a scene. By photographic or electronic means, a past image can be subtracted from the present one to emphasize the moving parts of a motion picture scene. Rhythms and patterns of motion become more noticeable, and changes in velocity can give an impression of accelerations and the force pattern.

In a motion picture, it is possible to emphasize those parts of a scene that move by suitable use of photographic or electronic methods. In essence, the method compares the image at one instant with that at a slightly later in-

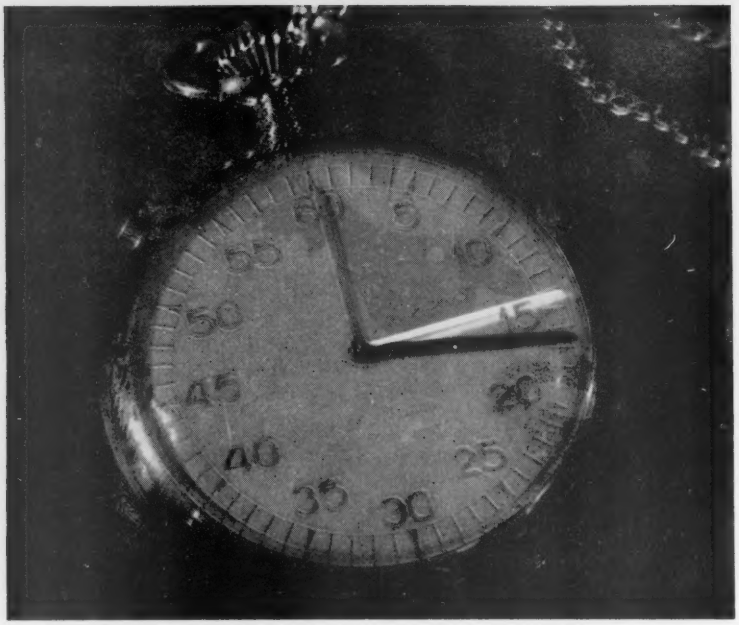

Fig. 1. Enlargement of a 16-mm motion-picture frame showing typical effect of sequential double printing. The stationary structure is deemphasized. Specular reflections from the watch stem and chain result in nonlinearity and less complete cancellation in those areas. The effect is more impressive when the pictures are projected in motion.

stant and displays only the differences between the two. The rhythms and patterns of motion can thus be made more noticeable. Applications include the study of motion in general and especially that propagated as waves, but my special interest is in speech and motion studies in connection with x-ray movies.

If a motion picture is to be studied in this fashion, one first makes a negative print from it, developed to a gamma of unity. The print and the original are then shifted a few frames relative to each other and projected together. The bright patterns of the stationary parts of the scene on the original will have superimposed upon them the dark patterns of the print. Within the linear portion of the H and D curve, stationary parts of the scene will thus register as a relatively uniform grey. Only those parts that do not coincide fail to cancel. The amount of relative shift used is chosen by taking into account the speed of the motion of interest, the stability of the projector, and the fineness of detail in the scene. For example, a film of a clock face projected with a shift of 20 frames relative to the negative will show the second hand moving, the other hands and the face being almost uniformly grey. Register and processing are important in creating the uniform background. Imperfection in either will allow the background to show up dimly, but this is convenient for orientation. In general, the purpose of the display is to outline objects that move and to emphasize brightness gradients in the subject that shift; fine details may appear double.

If no projector suitable for showing two films at once is available, a single print can be made from a positive and negative of the original. This print can then be developed to high gamma. In using an ordinary movie printer, one must make the final print by printing from two films of identical gamma, both printed from the original and one having been developed as a direct positive and the other as a negative. The positive and the negative can then be printed one after the other onto the final film, and in both runs there will be contact between emulsions for good focus. A very light or dark object will print through, since a transparent region in one film cannot be cancelled by the corresponding opaque region on the other film. However, if one can stay in the linear region and avoid saturation of the film, then it will not be necessary to print from both films at once in a special optical printer. For then the final exposure is the sum of its two parts, and extra light from one film will be compensated for by less light from the other. Simultaneous printing is desirable not only because one less intermediate film is required but also because a greater brightness range can be handled, due to the exposure of the final film to differences only.

Figure 1 shows a subject in which there were strong contrasts; the film was processed sequentially. Attention is attracted to the faster-moving watch hand; the other one is less noticeable. Despite the wide range of brightness in the subject, extreme care was not needed to obtain this degree of cancellation. The large frame shift produced considerable doubling. The sense of motion, if not previously known, would be indicated by the dark component's leading the light one (though the effect would be reversed if the background were dark or if the opposite film shift had been employed).

A television magnetic tape recorder can be used to provide the same result in two ways. Information stored on a video tape can be immediately displayed in this fashion if a double pick-up head is used, the two outputs feeding a difference amplifier. Alternatively, any incoming image can be directly converted to this form by splitting the signal along two paths, one going toward the output device and one to the recording head of a video recorder. The read-out head farther along "plays" into the output device, which contains a difference amplifier, and thus displays the difference between the signal at this stage and the signal at a fixed previous time. There is an erase head after the read-out head, and thus a continuous loop of tape may be used. In this mode of operation the tape recorder functions as a delay line; any other memory device or circuit could function similarly if it had sufficient storage capacity and speed. The noise level in presently available video tape recorders is rather objectionable in this application. However, a radiologist, if he is not administering an excess dose, is accustomed to fluctuations or noise of this magnitude, and, therefore, in x-ray applications a tape recorder may prove acceptable. The effect of noise in the recorder can be reduced by repeating each scene several times in a period that is much shorter than that of the original action.

The foregoing discussion pertains to moving pictures and extended observation, but this general method can be applied to any pair of images, and it then does not necessarily involve more than two ordinary pictures. One can use color in a similar way by dyeing two films different colors and forming a final color print (*1*).

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Note

1. The help of Leo Diner Films of San Francisco with the photographic work is gratefully acknowledged.

25 November 1958

Alterations in the Pattern of Amine Excretion in Man Produced by a Monoamine Oxidase Inhibitor

Abstract. The administration of monoamine oxidase inhibitors produces an increase in the urinary excretion of many amines for which efficient alternate routes of metabolism are not available. These include tryptamine, paratyramine, and a "metatyramine-like" substance. The inhibitors can therefore be used to detect previously unsuspected pathways of amino acid decarboxylation. The finding that the excretions of norepinephrine, epinephrine, 3,4-dihydroxyphenylethylamine, and possible serotonin are not appreciably affected are consistent with previous reports of the existence of alternative metabolic routes.

Drugs which inhibit monoamine oxidase (MAO) are being widely used as tools in research and as therapeutic agents in conditions such as psychic depression, angina pectoris, and hypertension. At present their pharmacologic actions are being considered entirely from the standpoint of the inhibition of serotonin (5-hydroxytryptamine) and norepinephrine metabolism in tissues such as brain and heart. While it is true that MAO inhibitors block completely the oxidative degradation of these two amines in vitro, other pathways for metabolism of the amines exist in vivo (*1*). The presence or absence of efficient alternate pathways for a given amine can be detected by determining whether or not the amount of amine excreted in the urine is increased during MAO inhibition. It was decided, therefore, to study the excretion of amines in patients receiving the MAO inhibitor 1-phenyl-2-hydrazinopropane (JB-516, Catron), since it has already been shown that this drug, in tolerable clinical dosage (*2*), effectively inhibits amine oxidase in man.

Four patients with uncomplicated hypertension were used for these studies. Twenty-four-hour collections of urine were obtained before and during therapy with JB-516 in a daily dose of 25 mg. Free norepinephrine and epinephrine were assayed fluorometrically by a modification (*3*) of the trihydroxyindole method, following adsorption of catecholamines on alumina at *p*H 8.4 and elution with 0.2*N* acetic acid (*4*). Dopamine (3,4-dihydroxyphenylethylamine), was determined in the same eluates by the method of Carlsson and Waldeck (*5*). The method used for serotonin was that described by Udenfriend, Weissbach, and Brodie (*6*). Tryptamine was measured by a method described elsewhere (*7*). For paratyramine determinations, 10-ml samples of urine were extracted, as described by Mitoma *et al.* (*8*), and the final acid extract was assayed fluorometrically, as reported for tyrosine (*9*).

As shown in Table 1, there were no significant changes in the urinary excretions of norepinephrine, epinephrine, and dopamine with MAO inhibition; this indicated the existence of efficient alternate pathways for the metabolism of these amines. Data for serotonin are not presented in the table becaues the chemical methods of determination are not suitable when urinary excretion is less than 500 μg/day. However, comparisons for all four patients were made before and after administration of JB-516, and in no instance did the levels rise to detectable values. In contrast, the excretions of tryptamine and of paratyramine were increased markedly. In other experiments daily excretions of these two amines have risen as high as 1100 μg for the former and 2400 μg for the latter.

Preliminary studies have also shown that MAO inhibition produces a marked increase in many urinary amines, the majority of which are as yet unidentified. One such substance has been tentatively identified as metatyramine. It has been isolated by passing samples of urine (3 percent of a 24-hour volume) through a Dowex 50-NH_4^+ column at a neutral *p*H, followed by elution with 3*N* NH_4OH. Eluates were concentrated in a vacuum and chromatographed on paper with butanol, acetic acid, and water (8:2:2). Metatyramine yields a characteristic light blue color at R_f of 0.65 when the chromatograms are sprayed with 0.1-percent 2,6-dichloroquinone chloroimide in alcohol, followed by 0.5*M* borate buffer, *p*H 9.3. Tentative identification has been achieved by comparing the R_f values of the material obtained from urine with those of authentic metatyramine in four solvent systems. These, and the colors obtained with several reagents, were found to be identical with those of the authentic compound.

These results indicate that decarboxylation of amino acids is a more common phenomenon than has been suspected and that MAO inhibition should be viewed in the perspective of a general alteration in the metabolism of amines. The finding that the actions of an amine such as tryptamine, which has weak biologic activity, are greatly potentiated in animals treated with MAO inhibitors (*10*) supports this concept. Furthermore, the tryptamine content of tissues, including brain, can be greatly increased by administration of L-tryptophan to animals after MAO blockade (*11*). In six patients the administration of L-tryptophan (20 to 50 mg/kg) during therapy with JB-516 (25 mg/day) produced marked central effects, including hyperreflexia, clonus, and symptoms similar to those that follow the ingestion of ethanol (*7*). The absence of such symptoms when tryptophan alone was given suggests that the agent producing these effects is an amine metabolite of tryptophan.

The MAO inhibitors will undoubtedly prove valuable for the identification and study of many amines which are otherwise almost completely metabolized. The demonstration of such unsuspected products of amino acid decarboxylation is also of clinical interest, particularly in view of the findings with tryptophan, since it indicates that the dietary intake of amino acids is an important factor to consider in evaluating the actions of MAO inhibitors.

Table 1. Urinary excretion of amines before and during MAO inhibition with JB-516.

Case No.	Control (μg/day)	During inhibition* (μg/day)
	Norepinephrine	
1	33, 14	26, 49
2	15, 17	10, 8
3	26, 39	36
4	97	58
	Epinephrine	
2	8, 7	4, 5
3	8, 11	14
4	20	15
	Dopamine	
1	270, 160	240, 160
2	320, 270	360, 260
3	390, 160	410
	Tryptamine	
1	68, 45	640, 940
2	71, 52	412, 362
3	60, 50	834, 735
4	99, 101	555, 616
	p-*Tyramine*	
1	190, 370	1060, 1180
2	242, 300	784, 615
3	315, 361	1420, 1280
4	320, 430	805, 960

* After 5 to 10 days of treatment.

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26 March 1959

Association Affairs

Additional Program Notes, Hotel Headquarters, and Housing for the Chicago Meeting

The preliminary announcement of the seventh Chicago meeting of the American Association for the Advancement of Science, 26–31 Dec. 1959 [*Science* **129**, 1431 (22 May 1959)] was principally an outline of the many sessions of the 18 AAAS sections and of some 80 participating organizations. It was apparent that the Chicago meeting will be well balanced in its coverage—that every principal field of science, from astronomy to zoology, will be represented. Since virtually all the sessions will be held in four hotels within two blocks of one another, the meeting will also be particularly convenient.

Additional details of the program of this 126th AAAS meeting have come in since the publication of the preliminary announcement. In several instances symposia have been expanded, speakers of prominence have accepted invitations, and program chairmen have raised their original attendance estimates.

Supplementing the program material of the preliminary announcement, are two symposia sponsored by Section F–Zoological Sciences. One of these, on the organization of the cell, is being arranged by Norman G. Anderson (Oak Ridge National Laboratory); the other, to be composed of two sessions on applications of electron microscopy to zoological research, is the responsibility of Austin M. Brues (Argonne National Laboratory). These two symposia are additional to the one on "Unsolved Problems in Biology IV," which is being jointly sponsored by Section F and Section G–Botanical Sciences.

The symposium of the Chicago Academy of Sciences, being arranged by Richard A. Edgren (Chicago Academy of Sciences), will be on the "Physiology of Reproduction in Birds" and will occupy four sessions. Speakers are: R. A. Edgren, Albert Wolfson, C. L. Ralph, A. V. Nalbandov, and T. W. Harris. L. B. Arey, president of the Academy, will welcome the attendance.

The four areas of the symposium, "Interaction in Nature: A Symposium on Modern Ecology" (27 and 28 Dec.), organized by Arthur D. Hasler for the American Society of Naturalists, and cosponsored by the Ecological Society of America and the American Society of Limnology and Oceanography are population ecology (Paul B. Sears, Thomas Burnett, and Thomas Park), conversion of energy (Basil Slobodkin, Howard T. Odum, and George L. Clarke), nature of adaption in plants (Edwin B Kurtz, Jr., and John T. Curtis), and ecology of behavior (Talbot H. Waterman, William S. Hoar, and Theodore Bullock).

Besides the cosponsorship of much of Section L's program, the Philosophy of Science Association will have a session on the nature of public interest with Wayne A. R. Leys (Roosevelt College) in charge.

The two-session symposium on the upper atmosphere, being arranged for the American Geophysical Union by Stanley Ruttenberg, (National Academy of Sciences–U.S. National Committee for the IGY) will be officially cosponsored by the U.S. National Committee for the International Geophysical Year.

AAAS headquarters and center of the meeting will be the "world's tallest hotel," the 46-story Morrison, which has separate entrances on Clark and Madison streets. In recent years, the 1800-room Morrison's exhibit facilities have been expanded, and new sessions rooms have been created; thus this hotel in itself can accommodate conventions of considerable size. The Morrison will be the location of the AAAS Main Registration-Information Center; the Visible Directory of Registrants; AAAS Office, Pressroom, and Science Theatre; and the large-scale exhibits of the Annual Exposition of Science and Industry.

The Terrace Casino and the Grand Ballroom of the Morrison, between them, will accommodate the AAAS general symposium, "Moving Frontiers of Science IV"; the AAAS presidential address (by Wallace R. Brode) and reception; all of the larger sessions each morning and afternoon; and the evening addresses of the United Chapters of Phi Beta Kappa–Society of the Sigma Xi, the Tau Beta Pi Association, and the National Geographic Society. The Biologists' Smoker (29 Dec.) and the AAAS Smoker for all registrants (30 Dec.) will also be held in the Terrace Casino.

These and other public rooms of the Morrison will be used for the joint sessions of the American Geophysical Union and the IGY, the Scientific Research Society of America address, the AAAS business sessions, and other events of general interest. A majority of the sectional programs, such as those in physics, botany, zoology, medical sciences, pharmacy, and agriculture will be held in the Morrison.

The Hamilton Hotel, on Dearborn Street around the corner from the Madison Street entrance of the Morrison, will be almost as convenient as the Morrison to the Visible Directory, Science Theatre, and exhibits. In general, the sessions of Sections C–Chemistry, E–Geology and Geography, and Nd–Dentistry will be held at the Hamilton.

Section Q–Education and the science-teaching societies—the National Association of Biology Teachers, the National Association for Research in Science Teaching, the National Science Teachers Association, the American Nature Study Society, and the Central Association of Science and Mathematics Teachers—will be based at the Hotel Sherman, shared by the annual convention of the Illinois Education Association. The Hotel LaSalle will house most of the sessions of Sections H, K, L, and P and the societies affiliated with or related to them.

A detailed list of the headquarters for each section and participating organizations is appended, since it is an obvious convenience for each person attending the meeting to have this information before he applies for room reservations.

Housing

The four hotels for the AAAS meeting have all established special rates, much lower than their usual rates, for the AAAS members and others attending the meeting. Thus everyone who makes room reservations through the AAAS Housing Bureau can be assured of substantial savings.

Beginning with this issue of *Science*, the advertising pages will carry, at frequent intervals, announcements of hotel accommodations and rates, together with a coupon which should be filled out and sent, *not* to any hotel directly, but to the AAAS Housing Bureau in Chicago. All applications for hotel rooms will be filled in the order of receipt. Those who apply early are assured of the hotel of their first choice. Moreover, since large blocks of rooms have been reserved at each price level, early applicants can expect that a room can be supplied at their requested minimum rate. All confirmations will state the rate assigned. It is suggested that the *maximum rate*, which you do not wish to exceed, and your *desired rate* both be stated on your housing application.

Room expenses can be reduced still further if rooms are shared by two persons or if suites are shared by three or more persons. Upon request, all hotels will place comfortable cots in rooms or suites at $3 per night. All children under 12 are free.

Registration

Both the technical, or program, sessions and the special sessions are open to all interested persons. Although registration for these sessions is not mandatory, it is expected that all who attend will wish to pay the AAAS registration fee of $3 and thus contribute a proportionate share to the heavy expenses of the meeting. (The registration fee for the spouse of a registrant, if a second General Program is not required is $1.)

Each registrant receives the General Program, convention literature, listing in the Visible Directory of Registrants, and a Convention Badge, which assures him all privileges of the meeting. The badge *is* required for admission to the large-scale exhibits, the AAAS Science Theatre, the presidential reception, and the AAAS Smoker. Refreshments are served at the last two events.

This year the General Program will be reduced to some 200 pages (8 ounces) by some compression of cross references but principally by the removal and separate printing of the directory. The General Program will be both more readable and easier to carry.

Advance registration has some decided advantages: delay at the registration desks upon arrival is eliminated; the General Program, which is sent out by first-class mail early in December, enables one, at leisure, to determine which events and sessions he particularly wishes to attend; and one's name is posted in the Visible Directory of Registrants as the meeting opens. (The hotel room can be added later, by the registrant himself, if he wishes.)

An announcement on advance registration and a coupon for it will also be found in the advertising pages of this issue of *Science* and at intervals hereafter.

The Directory of AAAS Officers and Activities has already been published. It may be ordered now, on the same advance registration coupon, or it may be secured at the meeting.

Hotels

Societies are grouped in the same sequence of disciplines as the letters of the AAAS sections.

Morrison (1800 rooms), 79 W. Madison St.: AAAS; Press; AAAS Committee on Science and the Promotion of Human Welfare; AAAS Sections A–Mathematics, B–Physics, D–Astronomy, F–Zoological Sciences, G–Botanical Sciences, I–Psychology, M–Engineering, N–Medical Sciences, Np–Pharmacy, and O–Agriculture.

Association for Computing Machinery, Society for Industrial and Applied Mathematics

American Astronautical Society, American Meteorological Society, Physics Club of Chicago

American Association of Clinical Chemists

Astronomical League

National Geographic Society, National Speleological Society

American Society of Zoologists, Society of Systematic Zoology

American Genetic Association, American Society of Limnology and Oceanography, American Society of Naturalists, Beta Beta Beta Honorary Biological Society, Ecological Society of America, Genetics Society of America, Society of General Physiologists

American Society of Plant Taxonomists, Botanical Society of America

Metric Association

Tau Beta Pi Association, Western Society of Engineers.

Alpha Epsilon Delta, American Physiological Society, American Psychiatric Association, Gerontological Society

American Association of Colleges of Pharmacy, American College of Apothecaries, American Pharmaceutical Association, Scientific Section, American Society of Pharmacists, National Association of Boards of Pharmacy

American Dairy Science Association, American Society for Horticultural Science, American Society of Agronomy, American Society of Animal Production, Poultry Science Association

American Geophysical Union, Chicago Academy of Sciences, Conference on Scientific Communication, International Geophysical Year, National Academy of Sciences, National Association of Science Writers, National Science Foundation, Scientific Research Society of America, Sigma Delta Epsilon, Society of the Sigma Xi, United Chapters of Phi Beta Kappa.

Hamilton (250 rooms), 20 S. Dearborn St.; AAAS Sections C–Chemistry, E–Geology and Geography, and Nd–Dentistry

American Chemical Society, Chicago Section

Association of American Geographers, Geological Society of America, Illinois Geographic Society

Engineering Manpower Commission

American College of Dentists, American Dental Association, International Association for Dental Research

Conference on Scientific Manpower, Scientific Manpower Commisison

La Salle (900 rooms), 10 N. La Salle St.: AAAS Sections H–Anthropology, K–Social and Economic Sciences, L–History and Philosophy of Science, and P–Industrial Science

American Economic Association, American Political Science Association, American Society of Criminology, American Sociological Society, American Statistical Association, National Academy of Economics and Political Science, National Institute of Social and Behavioral Science, New York Institute of Criminology, Pi Gamma Mu, Population Association of America

American Philosophical Association, Philosophy of Science Association, Society for General Systems Research, Society for the History of Technology

Institute of Management Sciences

Sherman (1600 rooms), Clark and Randolph Sts.: AAAS Cooperative Committee on the Teaching of Science and Mathematics; AAAS Section Q–Education

National Society for Medical Research

American Educational Research Association, Central Association of Science and Mathematics Teachers, Council for Exceptional Children, National Association of Biology Teachers, National Association for Research in Science Teaching, National Science Teachers Association

Academy Conference, American Nature Study Society.

RAYMOND L. TAYLOR
Associate Administrative Secretary

Forthcoming Events

August

23–27. **Veterinary Medicine, 3rd Pan-American Cong., Kansas City, Mo. (B. D. Blood, Pan-American Congresses of Veterinary Medicine, P.O. Box 99, Azul, Buenos Aires Province, Argentina.)**

24–26. **American Accounting Assoc., Boulder, Colo. (C. Cox, 437 Hagerty Hall, Ohio State Univ., Columbus 10.)**

24–26. **Anti-Submarine Warfare (classified), symp., San Diego, Calif. (R. R. Dexter, Inst. of the Aeronautical Sciences, 2 E. 64 St., New York 21.)**

24–26. **Dynamics of Conducting Fluids, symp. (American Rocket Soc. and Northwestern Univ.), Evanston, Ill., (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)**

24–27. **American Hospital Assoc., New York, N.Y. (E. L. Crosby, 18 E. Division St., Chicago, Ill.)**

24–28. **Australian and New Zealand Assoc. for the Advancement of Science, 34th cong., Perth, Western Australia. (J. R. A. McMillan, Science House, 157 Gloucester St., Sydney, Australia.)**

24–29. **Infrared Spectroscopy Inst., 10th annual, Nashville, Tenn. (N. Fuson, Director, Infrared Spectroscopy, Fisk Univ., Nashville 8.)**

24–29. **International Assoc. for Hydraulic Research, cong., Montreal, Canada. (IAHR, c/o Laboratoire Hydraulique, Raam 61, Delft, Netherlands.)**

24–29. **Ionization Phenomena in Gases,**

APPLICATION FOR HOTEL RESERVATIONS

126th AAAS MEETING

Chicago, 26-31 December 1959

The four hotels for the AAAS Chicago meeting have established special low rates and have reserved large blocks of rooms at each level within the price ranges quoted. Thus everyone making room reservations for the AAAS meeting is assured substantial savings. Further, all confirmations will state the room rate assigned.

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel reservation in Chicago. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Chicago and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

If desired, the hotels will add a cot at $3.00 per night—except that all children under 12 are free. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

For a list of the headquarters of each participating society and section, see page 228, *Science*, 24 July.

Rates for Rooms with Bath

Hotel	Single	Double Bed	Twin Bed	Suite
Morrison	$6.50– 9.00	$9.00–13.00	$11.00–15.00	$30.00 and up
Hamilton	6.50– 9.50	9.00–13.00	11.00–15.00	25.00 and up
La Salle	8.00–10.00	10.50–13.00	12.50–15.50	35.50 and up
Sherman	7.45–12.45	11.45–16.45	14.45–19.50	28.50 and up

THIS IS YOUR HOUSING RESERVATION COUPON

AAAS Housing Bureau
Suite 900
134 North La Salle Street
Chicago 2, Ill.

Date of Application .....

Please reserve the following accommodations for the 126th Meeting of the AAAS in Chicago, 26–31 Dec., 1959:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

.....

.....

First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

4th intern. conf., Upsala, Sweden. (A. Nilsson, Secretary-General, Inst. of Physics, Upsala, Sweden.)

24–29. Polarography, 2nd intern. cong., Cambridge, England. (Mrs. B. Lamb, Chemistry Lab., Evershed & Vignoles, Corner of Iveagh Ave., N. Circular Rd., London N.W.10, England.)

24–30. Modern Systems for Detecting and Evaluating Optical Radiation (Intern. Optical Commission), symp., Stockholm, Sweden. (S. S. Ballard, Dept. of Physics, Univ. of Florida, Gainesville.)

25–27. Petroleum Industry Conf., AIEE, Long Beach, Calif. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

25–28. Alaskan Science Conf., Alaskan Div., AAAS, 10th, Juneau. (N. J. Wilimovsky, Bur. of Commercial Fisheries, Box 2021, Juneau.)

25–28. American Dietetic Assoc., 42nd annual, Los Angeles, Calif. (Miss R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

25–30. American Ornithologists' Union, Regina, Saskatchewan, Canada. (H. G. Deignan, Div. of Birds, U.S. National Museum, Washington 25.)

26–28. Commemorating Soil and Water Conservation Progress, Soil Conservation Soc. of America, 14th annual, Rapid City, S.D. (H. W. Pritchard, 838 Fifth Ave., Des Moines 14, Iowa.)

26–29. International Assoc. of Milk and Food Sanitarians, Glenwood Springs, Colo. (V. T. Foley, Health Dept., Kansas City, Mo.)

26–29. International Union of Pure and Applied Chemistry, 20th conf., Munich, Germany. (Div. of Chemistry and Chemical Technology, Natl. Research Council, Washington 25.)

27–29. American Assoc., of Clinical Chemists, 11th annual, Cleveland, Ohio. (A. Hainline, Jr., AACC, Cleveland Clinic Foundation, 2020 E. 93 St., Cleveland 6.)

27–29. American Physical Soc., Hawaii. (K. K. Darrow, APS, Columbia Univ., New York 27.)

28–29. Weather Modification (with American Soc. of Civil Engineers), conf., Denver, Colo. (H. G. Houghton, AMS, Dept. of Meteorology, Massachusetts Inst. of Technology, Cambridge 39, Mass.)

28–30. American Folklore Soc., annual, Albany and Cooperstown, N.Y. (MacE. Leach, 110 Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

28–31. Astronomical League, Denver, Colo. (R. Dakin, 720 Pittsford-Victor Rd., Pittsford, N.Y.)

28–4. International Union for Scientific Study of Population, cong., Vienna, Austria. (F. Lorimer, Dept. of Sociology, American Univ., Washington, D.C.)

30–3. American Inst. of Biological Sciences, annual, University Park, Pa. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6.)

The following 17 meetings are being held in conjunction with the AIBS meeting at University Park, Pa.

American Microscopical Soc. (T. H. Cheng, Dept. of Zoology and Entomology, Pennsylvania State Univ., University Park.)

American Phytopathological Soc. (J. E. Livingston, Dept. of Botany and Plant Pathology, Pennsylvania State Univ., University Park.)

American Soc. for Horticultural Science. (R. E. Larson, Dept. of Horticulture, Pennsylvania State Univ., University Park.)

American Soc. of Human Genetics. (C. C. Li, Graduate School of Public Health, Univ. of Pittsburgh, Pa.)

American Soc. of Limnology and Oceanography. (E. L. Cooper, Dept. of Zoology, Pennsylvania State Univ., University Park.)

American Soc. of Parasitologists. (T. H. Cheng, Dept. of Zoology and Entomology, Pennsylvania State Univ., University Park.)

American Soc. of Plant Physiologists. (A. A. Benson, Agriculture and Biological Chemistry, Pennsylvania State Univ., University Park.)

American Soc. of Zoologists. (A. Anthony, Dept. of Zoology, Pennsylvania State Univ., University Park.)

Biometric Soc. (ENAR). (Miss C. S. Weil, Mellon Inst., 4400 Fifth Ave., Pittsburgh, Pa.)

Ecological Soc. of America. (M. W. Schein, Dept. of Poultry Husbandry, Pennsylvania State Univ., University Park.)

Genetics Soc. of America. (J. E. Wright, Dept. of Genetics, Pennsylvania State Univ., University Park.)

National Assoc. of Biology Teachers. (H. S. Fowler, Science Education, Pennsylvania State Univ., University Park.)

Nature Conservancy. (W. Sharp, Pennsylvania Cooperative Wildlife Reserve, 206 Forestry Bldg., Pennsylvania State Univ., University Park.)

Society for Industrial Microbiology. (Miss M. B. O'Hara, Applied Sciences Labs., Inc., State College, Pa.; or A. Rose, 525 S. Gill St., State College.)

Society of Protozoologists. (H. Frings, Dept. of Zoology, Pennsylvania State Univ., University Park.)

Society for the Study of Development and Growth. (J. E. Livingston, Dept. of Botany and Plant Pathology, Pennsylvania State University, University Park.)

Tomato Genetics Cooperative. (B. L. Pollack, Dept. of Horticulture, Pennsylvania State Univ., University Park.)

30–4. American Cong. of Physical Medicine and Rehabilitation, Minneapolis, Minn. (Miss D. C. Augustin, 30 W. Michigan Ave., Chicago 2, Ill.)

30–4. Laurentian Hormone Conf., Mont Tremblant, Quebec, Canada. (G. Pincus, 222 Maple Ave., Shrewsbury, Mass.)

30–4. Medical Education, 2nd world conf., Chicago, Ill. (World Medical Assoc., 10 Columbus Circle, New York 19.)

30–5. World Federation for Mental Health, 12th annual, Barcelona, Spain. (Miss E. M. Thornton, Secretary-General, WFMH, 19, Manchester St., London W.1, England.)

30–6. History of Science, 9th intern. cong., Barcelona and Madrid, Spain. (J. Vernet, via Layetona 141, Barcelona.)

30–6. Residues on Crops and/or the Problem of Insect Resistance to Insecticides, symp., Munich, Germany. (R. Morf, Secretary-General, IUPAC, c/o Sandoz, S. A., Basel, Switzerland.)

30–6. Thermodynamics and Experimental Thermochemistry, 17th intern. cong. (Intern. Union of Pure and Applied Chemistry), Munich, Germany. (Div. of Chemistry and Chemical Technology, Natl. Research Council, Washington 25.)

30–12. International Oceanographic Cong. (AAAS, UNESCO, ICSU), New York, N.Y. (Miss M. Sears, chairman, Woods Hole Oceanographic Institution, Woods Hole, Mass.)

31–2. Free Radical Stabilization, 4th intern. symp., Washington, D.C. (A. M. Bass, Natl. Bureau of Standards, Washington 25.)

31–2. Stratospheric Meteorology, conf., Minneapolis, Minn. (H. G. Houghton, AMS, Dept. of Meteorology, Massachusetts Inst. of Technology, Cambridge 39, Mass.)

31–3. Biological Photographic Assoc., Montreal, Canada. (Miss J. H. Waters, P.O. Box 1668, Grand Central Station, New York 17.)

31–3. Mathematical Assoc. of America, 40th summer meeting, Salt Lake City, Utah. (H. M. Gehman, MAA, Univ. of Buffalo, Buffalo 14, N.Y.)

31–4. Haematin Enzymes, symp. (by invitation), Canberra, Australia. (A. H. Ennar, John Curtin School of Medical Research, Australian National Univ., Canberra.)

September

1–3. Association for Computing Machinery, natl., Cambridge, Mass. (J. Moshman, Council for Economic and Industry Research, Inc., 1200 Jefferson Davis Highway, Arlington 2, Va.)

1–6. College of American Pathologists, Chicago, Ill. (A. H. Dearing, Suite 2115 Prudential Plaza, Chicago 1.)

1–7. History and Philosophy of Science (General Assembly, History Div., Intern. Union of the History and Philosophy of Science), Barcelona, Spain. (R. Taton, IUHPS, 64, rue Gay-Lussac, Paris 5e, France.)

1–8. Acoustics, 3rd intern. cong., Stuttgart, Germany. (E. Zwicker, Breitscheidstrasse 3, Stuttgart N.)

1–7 Oct. International Civil Aviation Organization (Meteorological Div.), Montreal, Canada. (ICAO, Maison de l'Aviation Internationale, Montreal.)

2–4. Allergy, 4th European cong., London, England. (British Assoc. of Allergists, Wright-Fleming Inst., St. Mary's Hospital, London, W.2.)

(See issue of 19 June for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable, and it reflects the claims of the manufacturer or other source. Neither Science *nor the writer assumes responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 238.*

■ FLASH X-RAY EQUIPMENT furnishes an x-ray pulse of about 1/6 μsec duration. Intensities are said to be adequate for fragmentation or explosion studies at distances up to 6 ft after penetration of x-rays through 1-in. plywood. The flash tube is tripod-mounted with height adjustable between 32 and 60 in. above floor level. The system may be fired by an externally generated input pulse, by closing a remotely located contact, or by depressing a panel push button. (Zenith Radio Corp., Dept. 931)

■ VARIABLE-RATE TURNTABLE is designed for testing inertial devices weighing up to 50 lb. Two models are available. A high-speed model has a dynamic range of ±1200 deg/sec. Range of the slow-speed model is ±1 deg/hr. The turntables can pass smoothly and repeatably through zero speed. Speed regulation is ±0.02 percent of range and previously programmed speed is repeated after stopping with accuracy within ±0.5 percent of maximum. A strip-chart recorder continuously indicates and records table speed. (J. W. Fecker, Inc., Dept. 932)

■ ELECTRON MICROSCOPE provides up to ×200,000 direct magnification for visual observation or for photographic recording on a 3¼-by 4-in. plate. Magnification is indicated with accuracy of ±5 percent. Resolving power is said to be 10 A or better. The electron-optical system includes six electromagnetic lenses. Minimum beam diameter is 1 to 2 μ at the specimen. Accelerating voltages of 40, 60, 80, and 100 kv, selectable during operation, are provided. Beam current is adjustable between 10 and 150 μa. Current stability of $\pm 5 \times 10^{-6}$ and voltage stability of $\pm 10^{-5}$ are claimed. Evacuation time after specimen change is 20 sec. (Philips Electronics, Inc., Dept. 934)

■ AUTOMATIC RECORDING TITRATOR is designed to make variable *p*H and constant *p*H titrations automatically. The recorder plots either variation of *p*H as a function of volume of titrating solution added, or the volume of titrating solution required to maintain constant *p*H as a function of time. For variable *p*H or EMF titration, a motor-driven burette delivers titrant to the cell as the sample is agitated by a magnetic stirrer. For derivative *p*H or EMF titration, the *p*H meter is coupled to the recorder through an electronic differentiator. Pro-

vision is made for plotting the second derivative function. For constant pH or EMF titration, a servomechanism is employed in which a motor-driven burette delivers titrant in response to an error signal received from a pH comparator. Titrant is fed until the preset value is reached. Precision of ±0.02 pH units or ±1.2 mv is claimed. Burette capacity is 1 ml for the standard unit, and cell volume is 15 ml. The temperature of the titration cell is maintained within ±0.1°C of the desired temperature. (Polarad Electronics Corp., Dept. 940)

■ VARIABLE TEMPERATURE BATH is controlled by ten separate thermistor controls over the range −55° to +100°C. Accuracy is ±0.1°C. Interiors are made of stainless steel. Units are equipped with 1 hp motors for agitation. Over-all dimensions are 46 by 36 by 38 in. (Labline Inc., Dept. 933)

■ MULTICHANNEL ANALYZER features plug-in units for pulse-height analysis, neutron time-of-flight measurement, pulsed-neutron decay measurements, or special-purpose program. The instrument provides 256 channels with 65,535-count capacity per channel. The main unit contains a magnetic-core memory, memory current drive circuits, memory cycle control binaries, address and arithmetic binaries, binary-to-analog converters, 3-in. cathode-ray-tube display, and power supplies. A variety of data read-out systems is available. (Technical Measurement Corp., Dept. 941)

■ NULL DETECTOR is a d-c instrument with 8 ranges of sensitivity from 10 μv to 100 v full scale. The instrument may be used as a d-c amplifier with gain of 100 db and input resistance 10 megohm. Two modes of operation, selectable by panel or foot switch, are provided. In the "hunt" mode 60 db of meter scale is available without switching. In the calibrate mode, the meter scale is linear from −1.2 to 0 to +1.2. (Boonton Electronics Corp., Dept. 937)

■ CALIBRATION STANDARD uses digital presentation of voltage and current. Voltages range from 1 mv to 2000 v in 12 ranges for d-c and in 14 ranges for a-c. Current range is 10 μa to 30 amp full scale, a-c and d-c. Accuracies of ±0.1 percent for d-c and ±0.3 percent for a-c are claimed. Protective interlocks prevent damage to instruments being calibrated. Accuracy can be increased by using a synchronous motor and generator set between the power line and the calibrator. (Radio Frequency Labs. Inc., Dept. 944)

■ ACCELEROMETERS of crystal type are designed to operate in ambient temperatures −65 and +540°F without cooling or correction. Sixteen models are available with sensitivities ranging from 30 mv/g to 1 mv/g and natural frequencies ranging from 65 to 150 kcy/sec. Output is said to be accurate to ±5 percent and linear to 8 kcy/sec and down to 2 cy/sec when the unit is used with the manufacturer's cathode follower and probe. (Columbia Research Lab., Dept. 938)

■ AIR MONITOR for particulate radioactivity detects alpha, beta, and gamma activity, records the amount on a continuous chart, and warns by light and bell when preset limits are exceeded. The unit will operate unattended for about 5 days. Maximum counting rate is 50,000 count/min. (Nuclear Measurements Corp., Dept. 936)

■ POWER SUPPLY furnishes 3 to 1000 v d-c at 500 ma. Full current is available at all voltage settings. Load and line regulation is 450 mv or 0.045 percent, whichever is greater. Maximum ripple is 8 mv r.m.s. (Dressen-Barnes Corp., Dept. 939)

JOSHUA STERN
National Bureau of Standards, Washington, D.C.

PERSONNEL PLACEMENT

CLASSIFIED: Positions Wanted, 25¢ per word, minimum charge $4. Use of Box Number counts as 10 additional words. Payment in advance is required. **Positions Open,** $33 per inch or fraction thereof. No charge for box number.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below—no charge for Box number. Monthly invoices will be sent on a charge account basis — provided that satisfactory credit is established.

Single insertion	**$33.00 per inch**
4 times in 1 year	**30.00 per inch**
7 times in 1 year	**28.00 per inch**
13 times in 1 year	**27.00 per inch**
26 times in 1 year	**26.00 per inch**
52 times in 1 year	**25.00 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS WANTED

Geneticist, Ph.D., minor physiology of reproduction, undergraduate training in animal husbandry. Desire teaching position. Frank Rice, Box 810, Miles City, Mont. 7/24, 31

Microbiologist, Ph.D. Desires research and/or teaching. Box 180, SCIENCE. X

Virologist. Ph.D. Competent in virology, tissue culture, and phages. Broad experience in medical bacteriology, mycology. Desires research position. Box 138, SCIENCE. 7/24, 31

POSITIONS OPEN

(a) **Bacteriologist;** M.S., Ph.D. experienced administration clinical bacteriology department; new 400-bed hospital to open fall 1959 replacing present 300-bed facility; teaching, research opportunity additionally; southeastern resort location. (b) **Biochemist;** Ph.D. preferred to head busy section, supervise eight technologists; ample research opportunity; university affiliated 400-bed general hospital; to $10,000; midwestern metropolitan area. (c) **Bacteriologist;** Ph.D. to conduct basic research and infectious diseases, participate in study, development of synthetic drugs; to about $10,000; prominent eastern concern. (d) **Pharmacologist;** Ph.D. to serve as technical director; primary emphasis new product development; well grounded in manufacturing procedures, analytical control; midwestern research laboratories. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

Biochemist, Medical. Ph.D. preferred. To supervise and develop procedures in central laboratory for pathology group serving five large hospitals in Los Angeles, California. Must be familiar with chromatography, electrophoresis and enzyme and steroid methods in clinical medicine. Address replies to Dr. Angus Wright, 679 S. Westlake, Los Angeles 57, California. 7/17, 24

BIOCHEMIST DEPARTMENT HEAD

Ph.D. or equivalent desired with broad interests in ENZYMOLOGY, METABOLISM and its disorders. Very attractive position in research division of progressive and expanding pharmaceutical firm. Please give detailed résumé of education and experience.

ETHICON, INC.
Route 22 **Somerville, New Jersey**

A Good-Sized Charcoal Manufacturer wants an **Experienced Production Man** with knowledge of building charcoal plants and making charcoal. Box 167, SCIENCE. 7/17, 24

POSITIONS OPEN

BIOLOGIST FOR AGRICULTURAL CHEMICALS RESEARCH

An exceptional opportunity for an experienced biologist is available with a leading chemical manufacturing company to assume the leadership of the biological phases of its agricultural chemicals research and development program.

The man for this position must have a Ph.D. degree in some branch of biological science, such as entomology, plant physiology or plant pathology. Extensive experience in the successful administration of an industrial pesticide research and development program is required and the candidate should be well established in his field and known for his accomplishments through publications and personal contacts.

This vacancy was created by the advancement of one of our key research men into an executive position; his replacement is of vital importance to our company in maintaining its strong competitive position and reputation in the field of agricultural chemicals which have been built over a number of years.

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Box 182, SCIENCE

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Box 179, SCIENCE

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